

THE CHICAGO ACADEMY OF SCIENCES

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The  
Paleontology of the Niagaran Limestone  
in the Chicago Area

THE TRILOBITA

BY

STUART WELLER

OF THE UNIVERSITY OF CHICAGO

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BULLETIN No. IV.

PART II.

OF

THE NATURAL HISTORY SURVEY

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ISSUED MAY 20, 1907

## LETTER OF TRANSMITTAL

CHICAGO, ILL., October 1, 1906.

DEAR SIR:

By direction of the Board of Managers of The Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you for publication a report on The Trilobita, to be issued, under, the rules of the Academy governing such matters, as Part II of Bulletin No. IV, on The Paleontology of the Niagaran Limestone in the Chicago Area, prepared by Stuart Weller of the University of Chicago.

Respectfully,

WILLIAM K. HIGLEY,

Chairman

To THOMAS C. CHAMBERLIN,

President of The Chicago Academy of Sciences.

The Board of Managers of The Natural History Survey of The  
Chicago Academy of Sciences:

WILLIAM K. HIGLEY, Chairman.

CHARLES S. RADDIN, Secretary.

THOMAS C. CHAMBERLIN.

GAYTON A. DOUGLASS

STUART WELLER.

## THE NATURAL HISTORY SURVEY

The report on the paleontology of the area covered by the Natural History Survey will be issued in parts, prepared by Dr. Stuart Weller, of the University of Chicago, and will constitute Bulletin No. IV.

The present report constitutes the second part of this bulletin and includes descriptions and figures of the Trilobita of the Niagaran limestone of Chicago and vicinity. Nineteen new species and one new genus are described and figured.. It is noteworthy that about forty per cent. of the species of North American Silurian trilobites have been recognized in the Chicago area. The description of these, together with the excellent illustrations prepared by Dr. Weller, will furnish a valuable manual on the subject for the use of students in local investigations.

The territory covered by the Survey includes Cook and Du Page counties and the nine north townships of Will County, in Illinois, with a portion of Lake County, Indiana. This gives an area of about forty-eight or fifty miles square, or a land surface of nearly 1,800 square miles.

The Board of Managers desires to acknowledge its obligations to the University of Chicago, the Field Museum of Natural History, the Northwestern University, as well as to the individuals whose courtesy to Dr. Weller greatly facilitated the work of preparing this report. Especial mention should be made of the generosity of our patrons, whose continued interest in the work of the Academy has made it possible to issue the present publication.

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## PREFACE

The present report upon the trilobites of the Niagaran limestone of the Chicago area is issued as Part II of Bulletin IV of the Natural History Survey of the Chicago Academy of Sciences, Part I of the same Bulletin being a description of the crinoids, published in 1900. In the preparation of the different parts of this Bulletin, no attempt is being made to follow the zoological order of sequence of the different groups of fossils, and the next class to be studied will probably be the Brachiopoda.

In the preparation of the present paper, the collections preserved in the Walker Museum of the University of Chicago have furnished most of the material, although the Egan collection in the museum of the Academy of Sciences has been freely drawn upon, as well as the collections of the Field Museum of Natural History.

The writer is under especial obligation to Mr. L. H. Hyde, formerly of Joliet, Illinois, but now of Pipestone, Minnesota, and to Messrs J. H. Handwerk and J. H. Ferris, of Joliet, for many important specimens. These gentlemen have collected extensively in the rock excavated from the Chicago drainage canal, and have secured much valuable material from near Lemont. Without the material furnished by them the paper would have been far from complete. The specimens used for illustration from their collections have been generously parted with and are now preserved in the collections of Walker Museum. Besides these gentlemen, Mr. G. H. Harris, of Chicago, has presented several important specimens to Walker Museum which have been made use of in the preparation of this paper. Another rich source of valuable material has been the Van Horne collection, recently presented to the Walker Museum by Sir William Van Horne. This collection contains many choice specimens from the Niagaran limestone of northeastern Illinois and southeastern Wisconsin, which have lent great assistance in the study of the trilobites of this region.

Most of the species which are here described are known to actually occur in the limestones of the Chicago area, but a few have been seen only from Wisconsin. These species, *Harpes telleri*, *Dicranopeltis nasuta* and *D. telleri*, were all collected by Mr. E. E. Teller, of Milwaukee, and are now in his collection.

The writer is under very great obligation to Mr. Teller, not only for the use of these specimens but also for the privilege, on several occasions, of examining his collection, a privilege which has rendered great assistance in the understanding of many of the species from the localities in the Chicago area.

The species described in this report are from several distinct horizons in the Niagaran limestone, and do not constitute a part of one compact fauna. The lowest horizon represented is a brown limestone from near Channahon, Will County, Illinois, near the Des Plaines river. The material from Joliet is higher, that from Lemont still higher, and that from Hawthorn and Bridgeport highest of all. The higher horizons are probably nearly as young as the Guelph formation of Canada and New York, while the lowermost may be as old as the Clinton in the New York section. Accurate correlation of these beds can be attempted, however, only when much additional detailed stratigraphic work has been done throughout the area.

A number of the species which have been recognized are closely related to European forms. Among these may be mentioned *Deiphon americanus*, *Staurocephalus obsoletus*, *Ceratocephala goniata*, etc., and the presence of such forms in the interior of North America, adds strength to the hypothesis of communication between this region and northern Europe by way of the north polar region, which was set forth in the "Geologic Introduction" to part I. of this Bulletin.

Since the publication of the "Geologic Introduction," however, it has been established that there were two quite distinct faunal provinces in North America during Silurian time. One of these was the great Mississippian province in which the Chicago area lies, and it was this province that was in communication with north Europe during middle and later Niagaran time. During the time preceding this northern communication, while the Clinton beds were being deposited, it seems probable this Mississippian province was not so extensive and that its connection was with the Atlantic basin, perhaps in some southeasterly direction.

During later Silurian time a quite distinct faunal province occupied the northern Appalachian region. The sea in which this Appalachian fauna flourished, occupied an embayment from the Atlantic which stretched northward from Maryland across Pennsylvania and New Jersey into New York, which has been called the Cumberland basin by Ulrich and Schuchert.\* The

\*Rep. N. Y. State Paleontologist. for 1901. p. 647 (1902).

Cumberland basin was probably initiated in early Silurian time, and continued to extend its boundaries while the waters were being withdrawn from the Mississippian basin, perhaps to the north, so that in age it is at its culmination younger than the Silurian Mississippian sea.

The age of the great mass of Silurian sediments of the Cumberland basin is probably about equivalent to that of the Salina beds of the interior, and is therefore younger than any of the Silurian beds of the Chicago area. However, these Cumberland basin faunas are the direct outgrowth from older Silurian faunas, without doubt contemporaneous with the Niagaran of the Chicago area and other portions of the interior, which flourished along the eastern shores of the Atlantic basin, and at its southern extremity in Maryland there are sediments which were deposited contemporaneously with the Niagaran formations of the interior.

In the appended bibliographic list of North American Silurian trilobites (pp. 185 to 210 of this Bulletin); one hundred and five species are recorded, and of this number forty-one, or nearly 40%, are recognized in the Chicago area, this being the largest number of Silurian trilobites recognized from any area of similar size in America.

With the exception of two or three figures, the accompanying illustrations have been made by Miss Mildred L. Marvin.



## INTRODUCTION\*

The branch or phylum of the animal kingdom known as Arthropoda or joint-footed animals, includes those segmented organisms furnished with a jointed, chitinous exoskeleton, each segment or somite of which is typically provided with a pair of jointed appendages which are also covered with the exoskeleton in like manner with the body proper. The segments of the arthropod body are more or less unequally developed and in many cases groups of them are united. Usually a greater or less number of the pairs of appendages which were primitively for the function of locomotion, have been specialized for the performance of other functions.

The major classification of the Arthropods into two subphyla is based upon the nature of the respiratory organs, the BRANCHIATA being those which breathe by means of gills, or by lungs or tracheæ which are metamorphosed from gills, and the TRACHEATA, those which breathe by tracheæ or air tubes. Each of these sub-phyla is divided into classes based upon the segmentation of the body and the modification of the appendages.

Under the BRANCHIATA two classes are recognized, the CRUSTACEA and the ACERATA. The crustaceans are, with few exceptions, aquatic animals breathing with gills, although a few carry on respiration through the general surface of the body; they possess one or two pairs of appendages, the antennæ, in front of the mouth, which are mainly sensory in function; back of the mouth there are several pairs of appendages which are more or less completely modified for serving the mouth, and back of these others whose function is for locomotion, either for walking or for swimming. Each appendage typically consists of a basal joint, the *protopodite*, which is continued distally in two jointed branches, the *exopodite* and the *endopodite*, each of which may be variously modified.

The ACERATA are arthropods which are primitively branchiate, but in which the branchiæ may function as gills or lungs, or they may be metamorphosed into air tubes or tracheæ which penetrate the body. The body is divided into a cephalothorax anteriorly and an abdomen posteriorly, the line between the

\*In the preparation of the following pages of the "Introduction" and "Classification of the Trilobite," the chapter upon this group of organisms in Eastman's translation of Zittel's Text Book of Paleontology, by Prof. C. E. Beecher, has been largely drawn upon. The matter has been somewhat rearranged and changed but in some cases nearly the same words have been used. The indebtedness of the writer to this work is here acknowledged.

two regions passing between the sixth and seventh pairs of appendages. The segments of the cephalothorax are usually coalescent, those of the abdomen being either free or not. The antennæ are absent. Two sub-classes are recognized under this class, the MEROSTOMATA being aquatic forms which are for the most part extinct, but are represented by the living *Limulus*; and the ARACHNIDA or spiders, scorpions and their allies, in which the primitive branchiæ have been modified for aerial respiration. Because of their terrestrial habits the arachnids are rarely preserved as fossils.

The TRACHEATA are divided into two classes, the MYRIOPODA or thousand-legged worms and centipedes, and the HEXAPODA or insects. The body of the myriopods is wormlike, and consists of a distinct head, followed posteriorly by numerous similar segments, each of which bears one or two pairs of appendages. The body of the mature insect, HEXAPODA, has the three regions, head, thorax and abdomen, fully differentiated. The appendages of the head are specialized sensory organs, the antennæ, and the mouth parts; the thorax bears the organs of locomotion, three pairs of legs and usually two pairs of wings.

In the process of growth all arthropods undergo a series of moults. The exoskeleton with which all are furnished, is capable of but limited expansion, so that if these creatures are to increase in size it is necessary for them to shed this covering periodically. With each successive moult the new exoskeleton which is secreted is somewhat larger than the preceding one. During the stages of immaturity the creatures assume after each moult, new characters which successively approach more and more nearly those of the mature individual, but after the adult characteristics of body and appendages have been acquired, the succeeding changes at the moulting periods are only an increase in size until the maximum dimensions have been attained. Among those aquatic arthropods, the crustaceans and some Acerata, whose habitat is most favorably situated for preservation in a fossil condition, the abandoned exoskeleton is frequently firm and hard and fully capable of being buried in the sand or mud to become fossilized at some later period. On account of their habit of moulting, each one of these creatures has an opportunity to leave a fossil record of itself as many times as the number of its moulting periods. This may account for the great abundance of fossil trilobites in some formations. The large number of fossil remains, in some cases, may not really mean that

the creatures were more numerous, when alive, than the associated molluscs or other forms which had but one chance to leave a record of their lives because they secreted but a single shell during their lifetime.

The trilobites, with which the present Bulletin has to deal, are a group of Arthropods which constitute the most primitive one of the three sub-classes of the Crustacea. They have been extinct since the close of Paleozoic time, and had their maximum development in the earlier periods of that era. During Silurian time when the trilobites here discussed were living, they had already passed the period of their greatest expansion and were just starting on their decline as an important element in the marine faunas of the earth. The beginning of the history of the trilobites is unknown, as they were already fully differentiated in Cambrian time when we have the first really definite evidence of life upon the earth. In all there have probably been over two thousand species of trilobites described, belonging to nearly two hundred genera.

The only portion of the trilobite commonly preserved in the fossil condition is the hard exoskeletal covering of the dorsal surface of the body. This test or carapace is rarely more than a millimeter in thickness, and is usually much thinner; it consists of thin laminae of carbonaceous matter and calcium phosphate, and in its original condition was more or less chitinous in character. In some forms the test is pierced with pores of greater or less size which give to the surface a punctate appearance. In many forms the surface is perfectly smooth and in others it is covered with rounded tubercles of variable size or with other sorts of surface ornamentation. Some forms, as will be seen by the specific descriptions later, are furnished with great hollow spines. In general form the carapace is usually sub-oval, rounded at both ends, and almost always longer than wide, and it is usually convex transversely. It is divided longitudinally by two dorsal or axial furrows into three regions or lobes, a character which first gave to these organisms the name trilobites. The central region is called the axis and in the living organism contained the principal organs, the viscera, the heart and the central ganglia of the nervous system. The two lateral regions are called pleura or pleural lobes. The body is also divided transversely into three regions, 1) the cephalon or head; 2) the thorax; and 3,) the pygidium or abdomen. Along its margin the carapace does not terminate as a simple lamellae, but is turned

under to form a reflexed margin or doublure. This doublure is separated from the dorsal test by a narrow space, and produces the hollow spines at the ends of the thoracic segments as well as the genal spines when they are present, also the infolded margin of the cephalon and the pygidium. Among some species of trilobites two forms have been observed, one broader and larger which has been considered to be the male, and a smaller and narrower form believed to be the female. Still another supposed sexual difference has been observed in at least one species of *Dalmanites*\* where the female form has a more ancestral type of glabella and rounded genal angles, the male exhibiting more progressive characters in the glabella and well developed genal spines.

The cephalon or head of the trilobite comprises the anterior one of the three transverse regions of the carapace, and is supposed to have originated through the coalescence of several segments in some unknown ancestral form. It is crescentiform, semicircular, semielliptical, or sub-triangular in form, and is sometimes greatly produced in front. Its postero-lateral angles are known as the genal angles and are often produced into spines of greater or less length, the genal spines. The axial portion of the head, bounded by the axial or dorsal furrows, is more or less sharply differentiated from the general surface and is called the glabella. The glabella is exceedingly variable in size and form; in its primitive condition it is divided by transverse furrows into five lobes which are supposed to represent the original five segments which have been consolidated. In many genera the primitive pentamerous lobation of the glabella has been nearly or wholly obscured by the modification or elimination of the transverse furrows. The five primitive lobes of the glabella are designated, beginning with the anterior one, the frontal lobe, the first, second and third pairs of lateral lobes, and the occipital segment or lobe. With the exception of the posterior one, the four transverse furrows of the primitive glabella are usually not continuous across the median portion of the glabella, they are designated, beginning anteriorly, the first, second and third lateral glabellar furrows, and the occipital furrow. The occipital furrow is always retained whatever may be the modification of the lateral furrows.

The pleural regions of the head or cephalon are called cheeks. In the great majority of trilobites each cheek is divided into

\*G. van Ingen, School of Mines Quart., Vol. 23, p. 69 (1901).

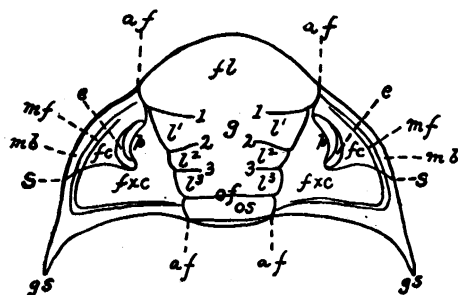


FIGURE 1.--The cephalon of a trilobite: *g*, glabella; *af*, axial or dorsal furrows; *fxc*, fixed cheeks; *fc*, free cheeks; *s*, facial suture; *fl*, frontal lobe of glabella; 1, 2, 3, first, second and third lateral glabellar furrows; *l¹*, *l²*, *l³*, first, second and third lateral glabellar lobes; *of*, occipital furrow; *os*, occipital segment; *p*, palpebral or eye lobes; *e*, visual surface of eye; *mf*, marginal furrow; *mb*, marginal border; *gs*, genal spines.

two portions by the facial sutures, and among the different orders, families and genera, these sutures are exceedingly variable in position and direction and are of great taxonomic value. The portion of the cheeks lying between the facial sutures and the dorsal or axial furrows are known as the fixed cheeks, and the out-

er portions as the free cheeks. The compound eyes, when present, are always situated upon the free cheeks adjacent to the facial sutures; the lobe-like extension of the fixed cheek adjacent to the inner margin of the eye is known as the palpebral lobe or eye lobe. The portions of the facial sutures lying in front of the eyes are known as their anterior limbs, while the portions back of the eyes are their posterior limbs. The anterior limbs of the facial sutures may unite and pass around the anterior end of the glabella, or they may remain separate, in which case they terminate at the anterior margin of the head; their posterior limbs may terminate at the posterior margin of the head, near the genal angles or upon the lateral margins of the head. That portion of the cephalon lying between the facial sutures, comprising the glabella and the fixed cheeks, is known as the cranidium. It frequently happens that the free cheeks have become separated before fossilization takes place, in which case the specimen consists of the cranidium alone. In many cases the marginal portion of the head, sometimes only laterally and again laterally and anteriorly, is differentiated from the general surface as a marginal border; this may be flattened, convex or concave, and may vary greatly or may be entirely absent. The furrow or groove limiting the marginal border internally is the marginal furrow. Frequently the cheeks are traversed near their posterior margins by furrows which originate at or near the lateral terminations of the occipital furrow of the glabella, and continue in a di-

rection more or less parallel with the posterior margin, towards the lateral margins of the head, sometimes becoming coalescent with the marginal furrows in front of the genal angles; these furrows are known as the posterior cheek furrows.

Most trilobites possess compound eyes, but a few genera are furnished with simple eyes or ocelli, while in a few others organs of sight seem to be absent altogether. The compound eyes vary greatly in size, sometimes being very small, while in a few forms they occupy nearly the entire area of the free cheek. In some genera, especially the earlier and more primitive forms, the eyes are situated at the distal extremities of elevated ridges or eye lines which extend outward from near the anterior extremity of the glabella. According to their structure, two kinds of compound eyes are recognized. In the great majority of genera the outer or visual surface of the eyes is covered with a smooth or granular integument which entirely obscures, externally, their compound nature. Such eyes are termed *holochroal*. Only a few genera, in fact only the members of a single family, possess the second or *schizochroal* type of eyes. In these the visual surface is made up of small, polygonal or rounded openings for the individual facets which are separated by an interstitial test. In the *schizochroal* eyes the facets are much larger than in the *holochroal* and can always be seen with the naked eye when they are well-preserved; in number they vary from fourteen to six hundred, while in the eyes of the *holochroal* type of structure the number of facets sometimes reaches fifteen thousand. The shape of the eyes is usually more or less crescentiform, with the visual surface on the convex side and directed laterally. In those trilobites in which the surface of the eyes describe a complete half circle, the facets are directed in such a manner as to receive the light from all directions, from the front, from the rear and from the sides.

Upon the ventral side of the cephalon, the hypostome, which is homologous with the upper lip or labrum of other crustaceans, is a separate plate attached by an articulating edge to the reflexed anterior border of the cephalic shield. In different genera the hypostome is more or less variable in shape, but it is frequently more or less deeply notched along its posterior border. Its position upon the under side of the animal is nearly horizontal. In some genera, especially among those in which the anterior limbs of the facial sutures are con-

tinuous around the anterior extremity of the glabella, the area in front of the hypostome is partly occupied by a separate plate which is sometimes visible dorsally. The remaining characters of the ventral side of the head, so far as they are known, will be described later in connection with the discussion of the ventral appendages.

The thorax of the trilobites consists of a series of short, transversely elongate, articulating segments, which vary in number among different genera from two to twenty-nine. Each thoracic segment consists of the central or axial portion lying between the dorsal or axial furrows, and the lateral or pleural portions. The axial portion is usually more or less strongly convex transversely; the pleura are usually depressed below the axis and have a proximal or inner more or less flattened portion, and a distal or outer portion which is bent more or less abruptly downward and backward, terminating in a backwardly pointing angular extremity. The articulation between the thoracic segments is in the axial region where each segment bears an anterior extension somewhat beneath the general surface and separated by a furrow, which passes beneath the incurved posterior margin of the segment in front. The pleura of the thoracic segments of many trilobites are grooved diagonally, the grooves originating near the anterior margin at the dorsal furrow and

from there passing obliquely outward and backward, often extending to the angular distal extremities. In some genera, however, the pleura are smooth throughout.

The posterior abdominal region of the trilobite is commonly known as the pygidium. Like the cephalon and thorax, it has a central axial region or lobe, with two lateral or pleural lobes separated from the axis by the axial or dorsal furrows; it is usually more or less arched transversely, especially in the axial region, though in some forms the pleura are more or less

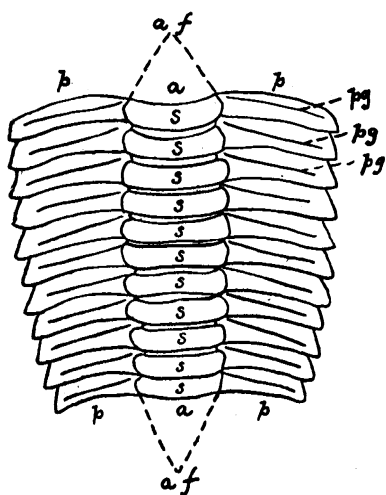


FIGURE 2.—Thorax of a trilobite: *a*, axial region; *p*, pleural regions; *af*, axial or dorsal furrows; *s*, segments; *pg*, pleural grooves.

completely flattened. In some genera the true elevated portion of the axis is short, being produced posteriorly into a post-axial region which is usually limited by the continuation of the dorsal or axial furrows, but which is not elevated above the surface of the pleural lobes. The pygidium consists of a single piece which has originated through the coalescence of several originally articulating segments. The original segmentation of the pygidium is usually more or less distinctly preserved, though in some forms it has become completely obsolete. It is somewhat difficult to detect the line of union between the thorax and pygidium in those forms with a strongly segmented pygidium, except in disarticulated specimens; but in those forms with obsolete segmentation of the pygidium, this line stands out strongly. The segments of the pygidium, like those of the thorax, may be either grooved longitudinally, or may be plain. There is usually a more or less definite relationship between the size of the pygidium and the number of thoracic segments, those trilobites with a large number of thoracic segments having a small pygidium, and conversely,

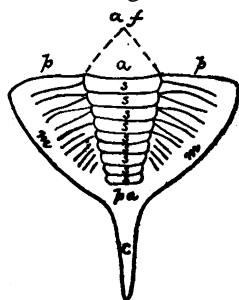


FIGURE 3. — Pygidium of a trilobite: *a*, axis; *p*, pleural lobes; *s*, segments of axis and pleura; *pa*, post-axial region; *af*, axial or dorsal furrows; *c*, caudal spine; *m*, marginal border.

forms with a smaller number of thoracic segments having a relatively larger pygidium.

The lateral and posterior margins of the trilobite pygidium are frequently entire, the outline forming a regular sub-elliptical, sub-circular or parabolic curve, or it may be sub-triangular in outline; in other forms the distal extremity of each pleural segment is produced into a spine-like process of greater or less length, and frequently a caudal spine, sometimes of great length, extends posteriorly in line with the axis from the posterior margin. The length of the elevated portion of the axis of the pygidium varies greatly, in some forms it being less than one-fourth the pygidium while in others it reaches to the posterior margin and may even be produced backward in the caudal spine. The segmentation of the pleura may reach to the lateral margins or it may stop short of the margin and leave a more or less flattened marginal border. The caudal spine, when present, may be a mere posterior extension of the marginal border or it may be a posterior extension of the axis proper.



The jointed thoracic segments of the trilobite overlap and admit of more or less motion upon one another, so that most trilobites possess the power of enrollment to a greater or less degree. In some cases the body is capable of being completely rolled up, the posterior margin of the pygidium coming into close apposition with the doublure of the head, thus entirely concealing the ventral surface. Other forms possessed this power to but a limited degree and in some it seems to have been lacking altogether.

The ventral surface of the trilobites is usually so firmly imbedded in the matrix in which the fossils are preserved, that it is inaccessible for study, and the paired, jointed appendages, even when present, cannot be exposed by ordinary methods because of their great delicacy. Until within the last decade, nearly all of our exact knowledge of the ventral surface of the trilobites and their appendages was derived from the sectioning of enrolled specimens.\* From a study of such material it was discovered that the creatures were covered externally upon the ventral side, with a thin membrane attached to the reflexed margins of the cephalon, thoracic segments and pygidium. This membrane was supported by transverse processes which became calcareous with age and to which the appendages were attached. More recently the structure of the ventral surface of *Triarthrus becki* Green, from the Utica slate near Rome, New York, has been made out in great detail, and these structures may be taken, in the main, as typical of the trilobites as a whole.

Each segment of the cephalon, thorax and pygidium, excepting only the anal segment, carries a pair of jointed appendages, all of which, save the anterior pair, are biramous. The anterior pair of appendages are the antenna, they are attached at the sides of the hypostome and consist of simple, many jointed flagella. All the remaining paired appendages are similar in structure and exhibit but a small amount of differentiation. Each appendage or limb consists of a basal joint or protopodite from which spring two branches. The inner branch or endopodite normally consists of six joints. The outer branch or exopodite has one long proximal joint with a distal multi-articulate portion; from this branch long setæ extend posteriorly and on the distal portion they are so crowded as to make a continuous fringe.

\*Walcott, Bull. Mus. Corp. Zool., Vol. 8, No. 10 (1881).

Besides the antenna, the cephalon bears four pairs of these pediform, biramous appendages, the protopodites of which are developed into large gnathobases which function as manducatory organs. In the higher crustaceans these cephalic appendages have been greatly differentiated as special organs for serving the mouth, but in the trilobites they still function in part as organs of locomotion, and except in the strong development of the gnathobases they do not differ materially from the thor-

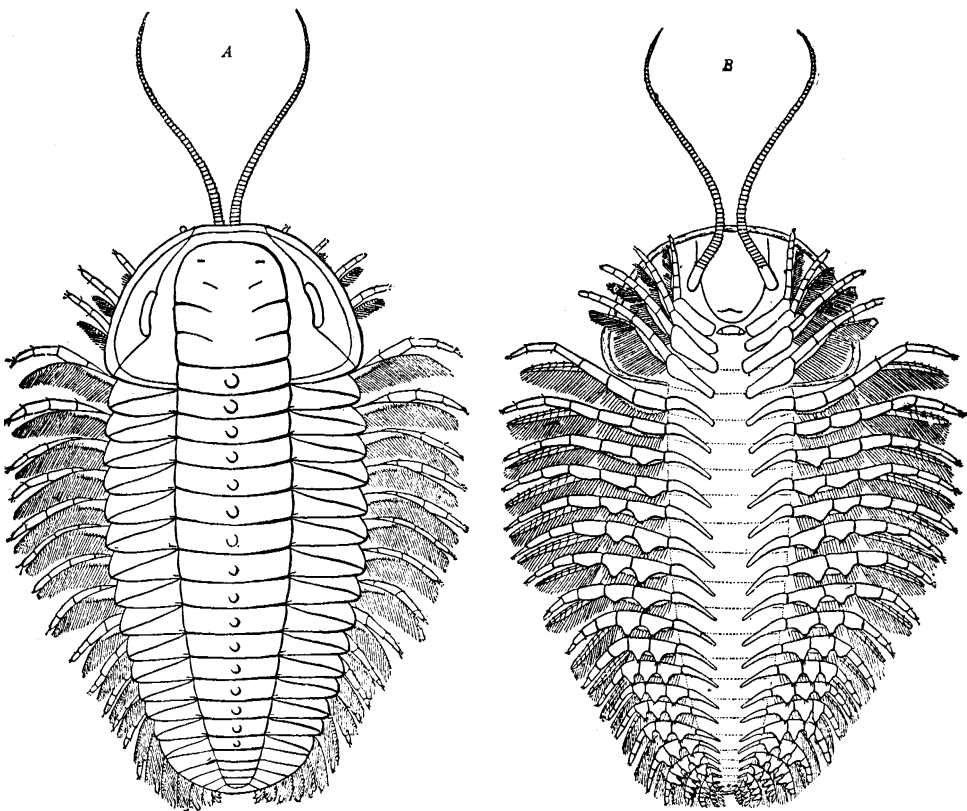


FIGURE 4.- *Triarthrus becki*, Green. A, dorsal, and B, ventral aspect (x2). After Beecher.

acic appendages and those of the pygidium, which are wholly locomotive in function. The endopodites are jointed, ambulatory or crawling legs; posteriorly, especially upon the pygidium, the joints become flattened and more or less leaf-like, carrying tufts of setæ, and are more adapted for swimming. The profusely fringed exopodites also function as swimming organs, although they serve in common with the entire membranous ventral surface, as organs of respiration.

## CLASSIFICATION OF THE TRILOBITA

In elaborating a natural classification of any group of organisms, a classification which will show the genetic relationships of the various forms, the best results have always been attained through the application of the law of morphogenesis which supposes that each individual, during its development from embryo to adult, passes through a series of stages which more or less closely resemble the stages through which the ancestors of this individual have passed in preceding ages. The principles of this law can best be applied in the classification of a group of organisms not made up of degenerate forms, and whose geologic history is more or less complete. The trilobites have a known life history beginning with the Cambrian and extending to the close of the Paleozoic, their structure is generalized and quite uniform throughout, no degenerate forms are known, and they satisfy most of the conditions necessary for the satisfactory application of the law of morphogenesis in building up a natural genetic classification.

In common with all organisms known only in the fossil form, the trilobites furnish almost no information in regard to the strictly embryonic stages of growth, although minute spherical or ovoid bodies have been found associated with trilobites and have been described as the eggs of these creatures. The smallest and most primitive fossil organisms exhibiting the characters of the trilobite, and which have been traced through successive stages to the adult, are small discoid or ovate bodies named the protaspis, and do not exceed 1 mm. in length. The protaspis stage has been found to be the normal larval form characteristic of all trilobites, and it is believed that it approximates the theoretical, primitive, ancestral larval form of the crustacea. The characteristics possessed by the protaspis, as now known in all the principal groups of trilobites, are given by Beecher as follows: "Dorsal shield minute, not more than 0.4 to 1 mm. in length; circular or ovate in form; axis distinct, more or less strongly annulated, limited by longitudinal grooves; head portion predominating; axis of cranium with five annulations; abdominal portion usually less than one-third the length of the shield; axis with from one to several annulations; pleural portion smooth or grooved; eyes, when present, anterior marginal or submarginal; free cheeks, when visible, narrow and marginal."

The principal changes which take place in the individual during growth are: 1. The gradual elongation of the body by the successive introduction of free thoracic segments: 2. The change in position of the eyes. 3. The modification of the glabella. 4. The growth of the free cheeks. 5. The final assumption of the mature specific characters of the pygidium, and the ornamentation.



FIG. 5.  
*Ptychoparia kingi*, Meek.  
Cambrian. A, Protaspis  
enlarged. B, Adult reduced.  
(After Beecher).



FIG. 6.  
*Sao hirsuta*, Barrande.  
Cambrian. A, Protaspis  
enlarged. B, Adult reduced.  
(After Beecher).



FIG. 7.  
*Triarthrus becki*, Green.  
Ordovician. A, Protaspis  
enlarged. B, Adult reduced.  
(After Beecher).



FIG. 8.  
*Proetus parviusculus*,  
Hall, Ordovician. A, Pro-  
taspis enlarged. B, Adult  
reduced. (After Beecher).



FIG. 9.  
*Acidaspis tuberculata*,  
Conrad, Lower Devonian.  
A, Protaspis enlarged. B,  
Adult reduced. (After  
Beecher).



FIG. 10.  
*Dalmanites socialis*,  
nande, Ordovician. A,  
Protaspis enlarged. B, Adult  
reduced. (After Beecher).

The simplest expression of the protaspis stage is found in the earliest genera known, those of the Cambrian; in later genera the process of acceleration or earlier inheritance has pushed forward the initiation of certain characters in the growth of the individual until they appear in the protaspis, thus making it far more complex than in the more primitive forms of the Cambrian. Many of the earlier and more primitive genera of trilobites, even in their adult form, retain certain characters suggestive of the protaspis. Any genus of trilobites with the cephalon large and elongate as compared with the pygidium, with the eyes rudimentary or absent, with the free cheeks ventral or marginal, with the glabella elongate, cylindrical, and with five annulations, would naturally be considered as belonging to a primitive stock.

During the protaspis stage the individual passes through several moults previous to the complete separation of the pygidium or the introduction of thoracic segments, which produce the stronger annulation of the axis, the appearance of the free cheeks upon the dorsal side and the increased seg-

mentation of the pygidium. The most important structures introduced during these changes in the protaspis itself, are the free cheeks, although in some forms these do not appear until after the close of the protaspis stage. Since the visual area of

the eyes, when present, is borne upon the free cheeks, these organs make their appearance upon the dorsal surface simultaneously with the free cheeks, and before they appear the free cheeks must be wholly ventral in position. When first discernible the free cheeks are very narrow; in some forms they include the genal angles, while in others they do not, the genal angles being borne by the fixed cheeks.

The complete ventral position of the free cheeks in the

earliest larval stages of all but the highest trilobites, indicates this to be a very primitive character, consequently several genera which possess ventral free cheeks as an adult character,



FIGURE 12. ---Ontogeny of *Sao hirsuta* Barrande. (*Opisthoparia*.) 1, Protaspis. 2, Cephalon of a very young individual. 3, Cephalon of an immature individual having eight free segments. 4, Cephalon of adult. (From Beecher, after Barrande.)

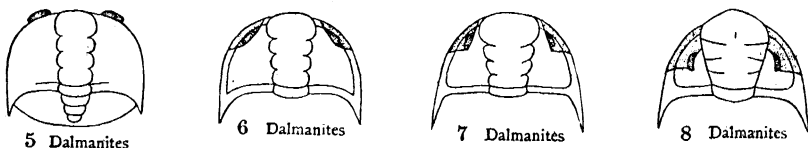


FIGURE 13.-Ontogeny of *Dalmanites socialis* Barrande. (*Proparia*.) 5, Protaspis. 6, Cephalon of individual with three free segments. 7, Cephalon of one with seven free segments. 8, Cephalon of adult. (From Beecher, after Barrande.)

along with other primitive features, may be assumed to occupy a very low rank, and are grouped together to constitute the most primitive order of trilobites, the *Hypoparia*.

As has already been mentioned, the remaining genera of trilobites present two distinct types of head structure dependent upon the character of the free cheeks and the direction taken

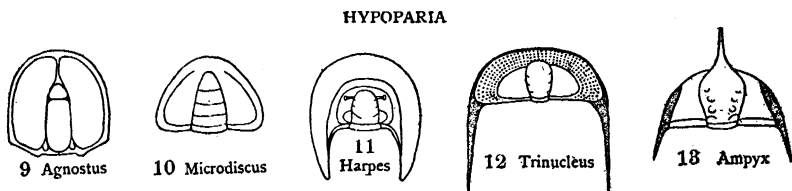


FIGURE 14.--Cephala of Hypoparia. 9, *Agnostus*; 10, *Microdiscus*; 11, *Harpes*; 12, *Trinucleus*; 13, *Ampyx*. (After Beecher.)

by the posterior limbs of the facial sutures. In both these types the free cheeks constitute an essential portion of the dorsal surface of the head and are continued to the ventral side only as a doublure or infolding of the margin. One type of structure is characterized by having the free cheeks include the genal angles, the distal extremity of the posterior limb of the facial suture cutting the posterior margin of the head. The genera possessing this type of structure constitute the second order, the *Opisthoparia*.

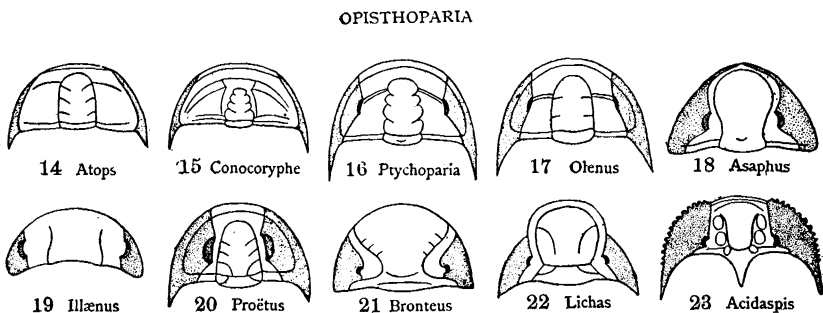


FIGURE 15.—14, *Atops*; 15, *Conocoryphe*; 16, *Ptychoparia*; 17, *Olenus*; 18, *Asaphus*; 19, *Illaenus*; 20, *Proetus*; 21, *Bronteus*; 22, *Lichas*; 23, *Acidaspis*. (After Beecher.)

In those forms representing the third type of structure, the genal angles are a part of the fixed cheeks, the posterior limb of the facial sutures being directed laterally from the posterior extremities of the eyes, their distal extremities cutting the lateral margins of the head. The genera having this type of structure are placed in the third order, *Proparia*.

Among the Silurian trilobites described in this Bulletin, all three orders are represented. The Hypoparia, however,

are represented by a single species, and this species has as yet been detected only at Milwaukee, although it is quite possible that it may yet be found within the Chicago area.

# PROPARIA

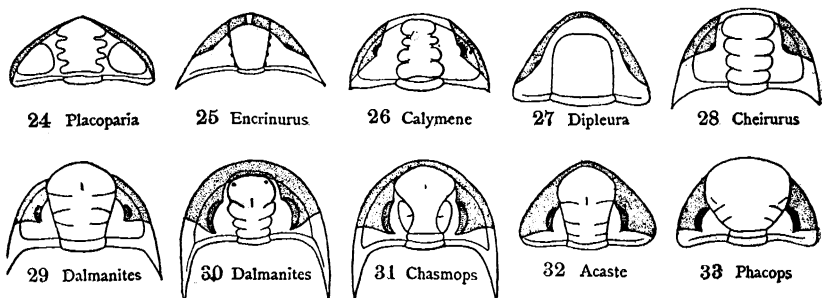


FIGURE 16.--Cephalons of Proparia. 24, *Placoparia*; 25, *Encrinurus*; 26, *Calymene*; 27, *Dipleura*; 28, *Cheirurus*; 29, 30, *Dalmanites*; 31, *Chasmops*; 32, *Acaste*; 33, *Phacops*. (After Beecher.)

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Niagara: Waldron, Ind.

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Niagara: Waldron, Ind.

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### **Acidaspis obsoleta** van Ing.

1901. *Acidaspis obsoleta*. van Ing., School of Mines Quart., vol. 23, p. 51, figs. 13-14.

Silurian: St. Clair Spring, Independence Co., Ark.

### **Acidaspis orton**i Foerste, see **Odontopleura orton**i Foerste.

### **Acidaspis perarmata** Whiteaves.

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Silurian: St. Clair Spring, Independence Co., Ark.

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Niagaran : Bridgeport, Ill.

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Lockport, N. Y.
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Niagara: Lockport, N. Y.
1852. *Lichas boltoni*. Hall, Pal. N. Y., vol. 2, p. 311, pl. 69, and pl. 70, figs. 1a-g, j-l (not figs. 1h, i = *Arctinurus nereus*).  
Niagara: Lockport, Rochester, Sweden and Walcott, N. Y.
1901. *Lichas boltoni*. Grabau, Bull. N. Y. St. Mus., No. 45, vol. 9, p. 225, pl. 17.  
Rochester shale: Niagara, Rochester, etc., N. Y.
- Arctinurus chicaoensis** Weller.
1907. *Arctinurus chicaoensis*. Weller, This Bulletin, p. 248, pl. 23, figs. 7-8, pl. 22, fig. 14.  
Niagaran : Hawthorn, Ill.
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Silurian: St. Clair Spring, Independence Co., Ark.
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1870. *Lichas obivius*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., (rev. ed.), p. 424, pl. 25, fig. 10.  
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1864. *Lichas boltoni* var., *occidentalis*. Hall, Trans. Albany Inst., vol. 4, p. 223.  
Niagara: Waldron, Ind.
1875. *Lichas boltoni*. W. & M., Geol. Surv. Ill., vol. 6, p. 508, pl. 25, fig. 5.  
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Niagara: Waldron, Ind.

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Clinton: Cumberland Gap, Tenn.
1907. *Arctinurus occidentalis*. Weller, This Bulletin, p. 247, pl. 20 figs. 10-12.  
Niagaran : Joliet and Bonfield, Ill.

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- Arges phlyctainodes** (Green), see **Corydocephalus phlyctainodes** (Green).
- Arges phlyctenoides depauperata** van Ing., see **Corydocephalus depauperatus**.

### ASAPHUS Brong. , 1822.

- Asaphus caudatus** Green, see **Dalmanites limulurus** (Green).
- Asaphus cordieri** Castel., see **Dalmanites limulurus** (Green).
- Asaphus corycaeus** Conrad, see **Proetus corycaeus** (Conrad).
- Asaphus coryphaeus** Hall, see **Proetus corycaeus** (Conrad).
- Asaphus limulurus** Green, see **Dalmanites limulurus** (Green).
- Asaphus wetherilli** Green, see **Dalmanites limulurus** (Green).

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Niagara: Racine, Wis.
1907. *Bronteus acamas*. Weller, This Bulletin, p. 232, pl. 20, fig. 1.  
Niagaran: Bridgeport and Romeo, Ill.

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Niagara: Kewaunee, Wis.
1882. *Bronteus laphami*. Whitf., Geol. Wis., vol. 4, p. 310, pl. 22, figs. 1-4.  
Niagara: Kewaunee, Wis.

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Niagara: Niagara river.
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Niagara: Niagara river.

**Bronteus occasus** W. & M.

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Niagara: Bridgeport, Ill.

**BRONGNIARTIA** Eaton, 1832.

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**Bumastus barriensis** Hall, see **Iliaenus ioxus** Hall.

**CALYMENE** Brong., 1822.**Calymene altirostris** van Ing.

1901. *Calymenne altirostris*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

**Calymene blumenbachii** (various authors), see **Calymene niagarensis** Hall, and **Calymene vogdesi** Foerste.

**Calymene camerata** Conrad.

1842. *Calymene camerata*. Con., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 278.

Schoharie, N. Y.

1852. *Calymene camerata*. Hall, Pal. N. Y., vol. 2, p. 337, pl. 78, figs. 1a-1f.

Coralline limestone: Schoharie, N. Y.

1903. *Calymene camerata*. Weller, Pal. N. J., vol. 3, p. 250, pl. 22, figs. 22-25.

Decker Ferry: Nearpass Quarry, N. J.

**Calymene clintoni** (Vanuxem).

1842. *Hemicrypturus clintonii*. Van., Geol. N. Y., pt. 3, p. 79, fig. 2.

Clinton: Vanhornsville, N. Y.

1843. *Hemicrypturus* tail. Hall, Geol. N. Y., pt. 4, p. 77, tab. org. rem., 9, fig. 2.

Clinton.

1852. *Calymene clintoni*. Hall, Pal. N. Y., vol. 2, p. 298, pl. A66, figs. 5a-5d.

Clinton: Herkimer and Cayuga Cos., N. Y.

1852. *Calymene blumenbachii*? var. *senaria*. Hall, Pal. N. Y., vol. 2, p. 299, pl. A66, figs. 6a-6e.

Clinton: New York.

**Calymene clintoni** Vogdes, see **Calymene vogdesi** Foerste.

**Calymene nasuta** Ulrich.

1879. *Calymene nasuta*. Ulrich, Jour. Cinn. Soc. Nat. Hist., vol. 2, p. 131, figs. 1-3, p. 132.

Niagara: Osgood, Ind.

**Calymene niagarensis** Hall.

1843. *Calymene niagarensis*. Hall, Geol. N. Y., pt. 4, p. 102, fig. 3, p. 101, tab. org. rem. 10, fig. 3.

Niagara: Lockport and Rochester N. Y.

1852. *Calymene blumenbachii* var. *niagarensis*. Hall, Pal. N. Y., vol. 2, p. 307, pl. 67, figs. 11-12.  
Niagara: Lockport and Rochester, N. Y.
1852. *Calymene* sp. Hall, Pal. N. Y., vol. 2, p. 350, pl. 83, fig. 8.  
Guelph: Gault, Ont.
1860. *Calymene blumenbachii*. Roemer, Sil. Faun. West. Tenn., p. 79, pl. 5, fig. 22.  
Decatur Co., Tenn.
1860. *Calymene blumenbachii* var. Hall, Can. Nat. and Geol., vol. 5, p. 156.  
Arisaig : Nova Scotia.
1862. *Calymene blumenbachii* var. *niagarensis*. Hall Geol., Surv. Wis., vol. 1, p. 432 (no description).  
Niagara: Milwaukee and Racine, Wis.
1865. *Calymene niagarensis*. Hall, Adv. Sheets, 18th Rep., N. Y. St. Cab. Nat. Hist., p. 30.  
Niagara: Wisconsin.
1867. *Calymene niagarensis*. Hall, 20th Rep. N. Y., St. Cab. Nat. Hist., p. 334.  
Niagara: Racine, Wis.
1868. *Calymene blumenbachii* var. Dawson, Acad. Geol. 2nd ed., p. 607.  
Arisaig: Nova Scotia.
1870. *Calymene niagarensis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 425.  
Niagara: Wisconsin.
1875. *Calymene niagarensis*. H. & W., Pal. Ohio, vol. 2, p. 153, pl. 6, figs. 14-15.  
Niagara: Cedarville, Eaton and Yellow Springs, Ohio.
1877. *Calymene niagarensis*. Hall, 28th Rep: N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 32, figs. 8-15.  
Niagara: Waldron, Ind.
1879. *Calymene niagarensis*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 187, pl. 32, figs. 8-15.  
Niagara: Waldron, Ind.
1882. *Calymene niagarensis*. Hall, 11th Rep. Dep. Geol. & Nat. Hist., Indiana, p. 331, pl. 34, figs. 8-15.  
Niagara: Waldron, Ind.
1888. *Calymene niagarensis*. H. & C., Pal. N. Y., vol. 7, pl. 1, figs. 10-14.  
Niagara: Waldron, Ind.
1895. *Calymene blumenbachii*. Whiteaves, Geol. Surv. Can., Pal. Foss., vol. 3, pt. 2, p. 106.  
Guelph: Gault, Ont.
1901. *Calymenne niagarensis*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).  
Silurian: St. Clair Spring, Independence Co., Ark.
1901. *Calymmene blumenbachi niagarensis*. Grabau, Bull. N. Y. St. Mus., No. 45, vol. 9, p. 224, fig. 156.  
Clinton: Niagara, N. Y.  
Rochester shale: Niagara, Lockport, etc., N. Y.



1903. *Calymmene niagarensis*. C. & R., Mem. N. Y. St. Mus., No. 5, p. 107, pl. 21, fig. 12.

Guelph: Rochester and Shelby, N. Y.

1904. *Calymene* cf., *Vogdesi*. Kindle, 28th Ann. Rep. Dep. Geol. & Nat. Res., Indiana, p. 482, pl. 24, figs. 1-7.

Niagara: Connors Mill, Georgetown and "Hanging Rock," Ind.

1907. *Calymene niagarensis*. Weller, This Bulletin, p. 261, pl. 23, figs. 9-10.

Niagaran : Bridgeport, Hawthorn, Joliet, near Lemont, etc., etc., Ill.

**Calymene phlyctainoides** Green, see **Corydocephalus phlyctainoides** (Green).

**Calymene rostrata** Vogdes.

1879. *Calymene rostrata*. Vogdes, Am. Jour. Sci., 3rd ser., vol. 18, p. 477. Clinton; Catoosa Station, Georgia.

1880. *Calymene rostrata*. Vogdes, Proc. Acad. Nat. Sci. Phil., for 1880, p. 176, figs. 1-2.

Clinton: Taylor's Ridge near Catoosa Station and Dug Gap, Georgia.

1881. *Calymene rostrata*. Vogdes, Pal. Cont., 1, p. 8, figs. 1 and 2 on accompanying plate.

Clinton: Catoosa Station and Dug Gap, Georgia.

1886. *Calymene rostrata*. Vogdes, Desc. New Crust. Clint. of Georgia, etc., p. 2, figs. 1-2.

Clinton: Near Catoosa Station and at Dug Gap, Georgia

1890. *Calymene rostrata*. Foerste, Proc. Bost. Soc. Nat. Hist. vol. 24, p. 267.

Clinton: Catoosa Station, Georgia, and New York.

**Calymene trisulcata** Hall, see **Phacops trisulcata** Hall.

**Calymene vogdesi** Foerste.

1880. *Calymene clintoni*. Vogdes, Proc. Acad. Nat. Sci. Phil., for 1880, p. 178, figs. 3-4. (not *C. clintoni* Van.)

Clinton: Catoosa Station and Dug Gap, Georgia;

1881. *Calymene clintoni*. Vogdes, Pal. Cont. 1, p. 9, figs. 3-7 on accompanying plate.

Clinton: Catoosa Station and Dug Gap, Georgia.

1886. *Calymene clintoni*. Vogdes, Desc. New Crust. Clint. of Georgia, etc., p. 5, figs. 3-4.

Clinton: Catoosa Station and Dug Gap, Georgia.

1885. *Calymene* ----. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 109, pl. 13, fig. 24.

Clinton: Near Dayton, Ohio.

1885. *Calymene blumenbachii* ? Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 110, pl. 13, fig. 25.

Clinton: Centerville, Ohio.

1887. *Calymene vogdesi*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 95.

Clinton: Near Dayton, Ohio; Catoosa and Dug Gap, Georgia.

1890. *Calymene blumenbachii* var., *vogdesi*. Foerste, Proc. Bost Soc. Nat. Hist., vol. 24, p. 265.

Clinton: Hanover, Ind.; Wilmington, Ohio; Collinsville, Ala.; Catoosa Station and Dug Gap, Ga.; Cumberland Gap, Tenn.

1895. *Calymene vogdesi*. Foerste, Geol. Surv. Ohio, vol. 7, p. 526, pl. 25, fig. 24-25; pl. 27, figs. 12-16.

Clinton: Ohio; Hanover, Id.; Lockport, N. Y.

### **CERATOCEPHALA** Warder, 1838.

#### ***Ceratocephala coalescens*** van Ing.

1901. *Ceratocephala coalescens*. van Ing., School of Mines Quart., vol. 23, p. 48, fig. 11, p. 41.

Silurian: St. Clair Spring, Independence Co., Ark.

#### ***Ceratocephala depauperata*** van Ing.

1901. *Ceratocephala goniata (depauperata)*. van Ing., School of Mines Quart., vol. 23, p. 42.

Silurian: St. Clair Spring, Independence Co., Ark.

#### ***Ceratocephala nodulata*** van Ingen.

1901. *Ceratocephala nodulata*. van Ing., School of Mines Quart., vol. 23, p. 44, fig. 10, p. 41.

Silurian: St. Clair Spring, Independence Co., Ark.

#### ***Ceratocephala goniata*** Warder.

1838. *Ceratocephala goniata*. Warder, Am. Jour. Sci., 1st ser., vol. 34, p. 378, fig.

Springfield, Ohio.

1862. *Acidaspis danai*. Hall, Geol. Surv. Wis., vol. 1, p. 432 (no description).

Niagara: Wisconsin.

1865. *Acidaspis danai*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 28.

Niagara: Bridgeport, Ill.

1865. *Acidaspis ida*. W. & M., Mem. Bost. Soc. Nat. Hist., vol. 1, p. 106, pl. 3, fig. 13.

Niagara: Bridgeport, Ill.

1867. *Acidaspis danai*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 333, pl. 21, figs. 8-9.

Niagara: Bridgeport, Ill.

1870. *Acidaspis danai*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., (rev. ed.), p. 423, pl. 21, figs. 8-9.

Niagara: Bridgeport, Ill.

1892. *Ceratocephala goniata*. Clarke, 44th Rep. N. Y. St. Mus. Nat. Hist., p. 91-100, pl. 1, fig. 1.

Springfield, Ohio.

1904. *Ceratocephala goniata*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 480, pl. 24, fig. 13.

Niagara: Pendleton, Indiana.

1907. *Ceratocephala goniata*. Weller, This Bulletin, p. 255, pl. 23, figs. 1-2.

Niagaran : Bridgeport and Hawthorn, Ill.

#### ***Ceratocephala goniata (depauperata)*** van Ing., see ***Ceratocephala depauperata*** van Ing.

**CERAURUS** Green, 1832.**Ceraurus bimucronatus** Roemer, see **Ceraurus niagarensis** Hall.**Ceraurus clintoni** Foerste.1887. *Ceraurus* ----. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 98, pl. 8, fig. 17.

Clinton: Near Dayton, Ohio.

1895. *Ceraurus (Pseudosphaerexochus) clintoni*. Foerste, Geol. Surv., Ohio, vol. 7, p. 527, pl. 27, fig. 17.

Clinton: Ohio.

**Ceraurus hydei** Weller.1907. *Ceraurus hydei*. Weller, This Bulletin, p. 264, pl. 24, fig. 22.

Niagaran : Near Lemont, Ill.

**Ceraurus insignis** Hall, see **Ceraurus niagarensis** Hall.**Ceraurus niagarensis** Hall.1852. *Ceraurus insignis*. Hall, Pal. N. Y., vol. 2, p. 300, pl. A66, fig. 4; also p. 303, pl. 67, figs. 9-10. (not *C. insignis* Beyr.)

Clinton: New York.

Niagara: Rochester, N. Y.

1860. *Ceraurus bimucronatus*. Roemer, Sil. Faun. West. Tenn., p. 80, pl. 5, fig. 19. (not *C. bimucronatus* Murch.)

Silurian: Decatur County, Tenn.

1862. *Ceraurus insignis*. Hall, Geol. Surv. Wis., vol. 1, p. 433 (no description) .

Niagara: Wisconsin.

1865. *Ceraurus insignis*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 31.

Niagara: Wauwatosa, etc., Wis.

1867. *Ceraurus insignis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 335.

Niagara: Wauwatosa, Wis.

1867. *Ceraurus niagarensis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 376, pl. 21, figs. 10-11.

Niagara: Wisconsin.

1870. *Ceraurus niagarensis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. ( rev. ed.), p. 427, pl. 21, figs. 10-11.

Niagara: New York and Wisconsin.

1877. *Sphaerexochus romingeri* ? Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 32, fig. 16.

Niagara: Waldron, Ind.

1879. *Ceraurus (Cheirurus) niagarensis*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 189, pl. 32, fig. 16.

Niagara: Waldron, Ind.

1882. *Ceraurus niagarensis*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 335, pl. 34, fig. 16, pl. 33, fig. 10.

Niagara: Waldron, Ind.

1884. *Ceraurus niagarensis*. Whiteaves, Geol. Surv. Canada; Pal. Foss., vol. 3, pt. 1, p. 42.

Guelph: Hespeler, Ont.

1895. *Ceraurus niagarensis*. Whiteaves, Geol. Surv. Canada; Pal. Foss., vol. 3, pt. 2, p. 107.

Guelph: Hespeler, Ont.

1901. *Ceraurus niagarensis*. van Ing. School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

1904. *Ceraurus (Crotalocephalus) niagarensis*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 483, pl. 23, figs. 1-2, pl. 24, fig. 8.

Niagara: Connors Mill, Marion and Georgetown, Ind.

1907. *Ceraurus niagarensis*. Weller, This Bulletin, p. 263, pl. 24, figs. 20-21.

Niagaran: Hawthorn and near Lemont, Ill.

### **CORYDOCEPHALUS** Corda, 1847.

#### **Corydocephalus byrnesanus** (M. & G.)

1893. *Lichas byrnesanus*. M. & G., Bull. No. 3, Ill. St. Mus. Nat. Hist., p. 78, pl. 8, figs. 8-9.

Niagara: Near Madison, Ind.

#### **Corydocephalus depauperatus** (van Ing.).

1901. *Arges phlyctenoides depauperatus*. van Ing., School of Mines Quart., vol. 23, p. 57.

Silurian: St. Clair Spring, Independence Co., Ark.

#### **Corydocephalus phlyctainodes** (Green).

1837. *Calymene phlyctainodes*. Green, Am. Jour. Sci., 1st ser., vol. 32, p. 167.

Springfield, Ohio.

1852. *Arges phlyctanoides*. Hall, Pal. N. Y., vol. 2, p. 314, pl. 70, figs. 2a-2c.

Niagara: Albion, N. Y.

1893. *Lichas hanoverensis*. M. & G., Bull. No. 3, Ill. St. Mus. Nat. Hist., p. 78, pl. 8, figs. 6-7.

Niagara: Hanover, Ind.

1907. *Corydocephalus phlyctainodes*. Weller, This Bulletin, p. 234, pl. 22, figs. 1-4.

Niagaran: Joliet and near Lemont, Ill.

#### **Corydocephalus ptyonurus** H. & C.

1888. *Lichas (Dicranogmus) ptyonurus*. H. & C., Pal. N. Y., vol. 7, p. 86, pl. 19B, figs. 19-21.

Coralline limestone: Schoharie, N. Y.

### **CRYPTONYMUS** Eichw., 1825.

**Cryptonymus ornatus** Vogdes, see **Encrinurus ornatus** H. & W.

**Cryptonymus nereus** Vogdes, see **Encrinurus nereus** Hall.

### **CYBELE** Loven, 1845.

**Cybele punctata** Hall, see **Encrinurus ornatus** H. & W.

### **CYPHASPIS** Burm., 1843.

#### **Cyphaspis arkansanus** van Ing.

1901. *Cyphaspis arkansanus*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

#### **Cyphaspis christyi** Hall.

1864. *Cyphaspis christyi*. Hall, Trans. Albany Inst., vol. 4, p. 220.

Niagara: Waldron, Ind.

1877. *Cyphaspis christyi*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.) , pl. 32, figs. 5-7.  
Niagara: Waldron, Ind.
1879. *Cyphaspis christyi*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.) , p. 188, pl. 32, figs. 5-7.  
Niagara: Waldron, Ind.
1880. *Cyphaspis christyi*. White, 2nd Ann. Rep. Dep. Stat. and Geol., Indiana, p. 498, pl. 3, fig. 9.  
Niagara: Waldron, Ind.
1882. *Cyphaspis christyi*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 333, pl. 34, figs. 5-7.  
Niagara: Waldron, Ind.

**Cyphaspis clintoni** Foerste.

1887. *Proetus* \_\_\_\_\_. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 92, pl. 8, fig. 5.  
Clinton: Dayton, Ohio.
1890. *Cyphaspis clintoni*. Foerste, Proc. Bost. Soc. Nat. Hist., vol. 24, p. 272, pl. 6, fig. 22.  
Clinton: Cumberland Gap, Tenn.
1895. *Cyphaspis clintonensis*. Foerste, Geol. Surv. Ohio, vol. 7, p. 524, pl. 27, fig. 5, pl. 31, fig. 22.  
Clinton: Ohio; Cumberland Gap, Tenn; Anticosti.

**Cyphaspis intermedia** Weller

1907. *Cyphaspis intermedia*. Weller, This Bulletin, p. 231, pl. 20 , figs. 3-5.  
Niagaran : Near Channahon, Will County, Illinois.

**Cyphaspis spinulocervix** van Ing.

1901. *Cyphaspis spinulocervix*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).  
Silurian: St. Clair Spring, Independence Co. Ark.

**DALMANIA** Emm. 1844.

**Dalmania bicornis** Hall, see **Dalmanites bicornis** Hall.

**Dalmania caudata** Roemer, see **Dalmanites limulurus** (Green).

**Dalmania danae** M. & W., see **Dalmanites danae** M. & W.

**Dalmania logani** Hall, see **Dalmanites logani** Hall.

**Dalmania verrucosa** Hall, see **Dalmanites verrucosus** Hall.

**Dalmania vigilans** Hall, see **Dalmanites vigilans** Hall.

**DALMANITES** Barr., 1872.

**Dalmanites arkansanus** van Ing.

1901. *Dalmanites (Synphoria) arkansanus*. van Ing., School of Mines Quart., vol. 23, p. 69, figs. 20-22.  
Silurian: St. Clair Spring, Independence Co., Ark.
1907. *Dalmanites arkansanus*. Weller, This Bulletin, p. 278, pl. 24, fig. 5.  
Niagaran : Near Lemont and near Romeo, Ill

**Dalmanites aspinosa** Weller.

1903. *Dalmanites aspinosa*. Weller, Pal. N. J., vol. 3, p. 252, pl. 22, fig. 15.  
Decker Ferry: Nearpass Quarry, N. J.

**Dalmanites bicornis** Hall.

1877. *Dalmania bicornis*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 33, fig. 18.  
Niagara: Waldron, Ind.
1879. *Dalmanites bicornis*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 196, pl. 33, fig. 18.  
Niagara: Waldron, Ind.
1882. *Dalmanites bicornis*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 342, pl. 35, fig. 18.  
Niagara: Waldron, Ind.

**Dalmanites danae** M. & W.

1865. *Dalmania danae*. M. & W., Proc. Acad. Nat. Sci. Phil., for 1865, p. 264.  
Up. Silurian: Near Thebes, Alexander Co., Ill.
1868. *Dalmanites danae*. M. & W., Geol. Surv. Ill., vol. 3, p. 263, pl. 6, figs. 1a—1f.  
Niagara: 2 miles above Thebes, Alexander Co., Ill.

**Dalmanites halli**, n. sp.

1877. *Dalmania vigilans*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 33, figs. 1-4 (not *D. vigilans*. Hall, 1862).  
Niagara: Waldron, Ind.
1879. *Dalmanites vigilans*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 193, pl. 33, figs. 1-4.  
Niagara: Waldron, Ind.
1882. *Dalmanites vigilans*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 339, pl. 35, figs. 1-4; pl. 33, fig. 9.  
Niagara: Waldron, Ind.

**Dalmanites illinoiensis** Weller.

1907. *Dalmanites illinoiensis*. Weller, This Bulletin, p. 275, pl. 25, figs. 1-2.  
Niagaran : Joliet, Bonfield and near Lemont, Ill.

**Dalmanites limulurus** (Green).

1832. *Asaphus limulurus*. Green, Monog. Tril. N. A., p. 48.  
Lockport, N. Y.
1832. *Asaphus caudatus*. Green, Monog. Tril. N. A., p. 50.  
Ripley, Ohio.
1832. *Asaphus wetherilli*. Green, Monog. Tril. N. A., p. 57.  
Near Rochester, N. Y.
1834. *Asaphus limulurus*. Harlan, Trans. Geol. Soc. Penn., vol. 1, pt. 1, p. 101.  
Lockport, N. Y.
1834. *Asaphus wetherilli*. Harlan, Trans. Geol. Soc. Penn., vol. 1, pt. 1, p. 101.  
Near Rochester, N. Y.
1843. *Asaphus limulurus*. Castel., Ess. Syst. Sil. l'Amer. Sept., p. 18, pl. 4, fig. 1.  
Lockport, N. Y.
1843. *Asaphus cordieri*. Castel., Ess. Syst. Sil. l'Amer. Sept., p. 18, pl. 4, fig. 2.  
Lockport, N. Y.

1843. *Asaphus limulurus*. Hall, Geol. N. Y., pt. 4, p. 101, fig. 1-2;  
also tab. org. rem., 10, figs. 1-2.

Niagara: Lockport and Rochester, N. Y.

1852. *Phacops limulurus*. Hall. Pal. N. Y., vol. 2, p. 303, pl. 67, figs.  
1-8.

Niagara: Lockport, N. Y.

1856. *Phacops limulurus*. Bill., Can. Nat. and Geol., vol. 1, p. 57, pl. 1,  
fig. 7.

Niagara: Ontario, Canada.

1860. *Dalmania caudata*. Roemer, Sil. Faun. West. Tenn., p. 82, pl. 5,  
fig. 21.

Silurian: Tennessee.

1901. *Dalmanites limulurus*. Grabau, Bull. N. Y. St. Mus., No. 45,  
vol. 9, p. 224, fig. 155.

Rochester shale: Niagara and Rochester, N. Y.

### **Dalmanites logani** Hall.

1860. *Dalmania logani*. Hall, Can. Nat. and Geol., vol. 5, p. 156.

Arisaig: Nova Scotia.

1868. *Dalmania logani*. Dawson, Acad. Geol., 2nd ed., p. 608, fig.  
215.

Arisaig.

### **Dalmanites platycaudatus** Weller.

1907. *Dalmanites platycaudatus*. Weller, This Bulletin, p. 272, pl.  
25, figs. 3-5.

Niagaran : Near Lemont, Ill.

### **Dalmanites verrucosus** Hall.

1864. *Dalmania verrucosa*. Hall, Trans. Albany Inst., vol. 4, p. 218.

Niagara: Waldron, Ind.

1877. *Dalmania verrucosa*. Hall, 28th Rep. N. Y. St. Mus. Nat.  
Hist. (doc. ed.), pl. 33, figs. 5-17; pl. 34, figs. 13-15.

Niagara: Waldron, Ind.

1879. *Dalmanites verrucosus*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist.  
(mus. ed.), p. 195, pl. 33, figs. 5-17; pl. 34, figs. 13-15.

Niagara: Waldron, Ind.

1882. *Dalmanites verrucosus*. Hall, 11th Rep. Dep. Geol. and Nat. Hist.,  
Indiana, p. 341, pl. 35, figs. 5-17; pl. 36, figs. 13-15.

Niagara: Waldron, Ind.

- 1907 *Dalmanites verrucosus*. Weller, This Bulletin, p. 280, pl. 25, figs.  
6-7.

Niagaran: Bonfield and Jersey County, Ill.

### **Dalmanites vigilans** Hall.

1861. *Dalmanites vigilans*. Hall, Rep. Prog. Geol. Surv. Wis., for  
1860, p. 51.

Niagara: Waukesha, Wis.

1862. *Dalmania vigilans*. Hall, Geol. Surv. Wis., vol. 1, p. 433, figs.  
3-4, p. 69 (no description) .

Niagara: Waukesha, Wis.

1865. *Dalmania vigilans*. Hall, Adv. Sheets, 18th Rep. N. Y. St.  
Cab. Nat. Hist., p. 31.

Niagara: Waukesha, Wauwatosa, etc., Wis.

1867. *Dalmania vigilans*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 335, figs. 1-2; p. 375, pl. 21, figs. 16-18.

Niagara: Waukesha, Wauwatosa, etc., Wis.

1870. *Dalmania vigilans*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 426, figs. 13-14, pl. 21, figs. 16-18.

Niagara: Waukesha, Wis.

1901. *Dalmanites (Synphoria) vigilans*. van Ing., School of Mines Quart., vol. 23, p. 67.

Silurian: St. Clair Spring, Independence Co., Ark.

1904. *Dalmanites (Synphoria) vigilans*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 485, pl. 23, figs. 4-7. pl. 24, fig. 20.

Niagara: Anderson and Pendleton, Ind.

1907. *Dalmanites vigilans*. Weller, This Bulletin, p. 276, pl. 24, figs. 1-4.

Niagaran : Jolie, and near Lemont, Ill.

### **Dalmanites werthneri** Foerste

1885. *Dalmanites werthneri*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 116.

Clinton: Near Dayton, Ohio.

1887. *Dalmanites werthneri*. Foerste, Bull. Sci. Lab. Den Univ., vol. 2, p. 101, pl. 8, figs. 22, 22a, 23-25.

Clinton: Near Dayton, Ohio.

1895. *Dalmanites werthneri*. Foerste, Geol. Surv. Ohio, vol. 7, p. 530, pl. 27, figs. 22, 22a, 23-25.

Clinton: Ohio.

### **DEIPHON** Barrande, 1850.

#### **Deiphon americanus** Weller.

1907. *Deiphon americanus*. Weller, This Bulletin, p. 268, pl. 24, fig. 14.

Niagaran : Joliet, Romeo and near Lemont, Ill.

#### **Deiphon forbesi** Barr.

1850. *Deiphon forbesii*. Barrande, Haidinger's Berichte, p. 6.

Etage E.: Bohemia.

1865. *Deiphon forbesi*. Salter, Monog. British Trilobites, p. 88, pl. 7, figs. 1-12.

Wenlock limestone and shale: England.

1895. *Sphaerexochus pisum*. Foerste, Geol. Surv. Ohio, vol. 7, p. 528, pl. 37A, figs. 14a-14b.

Niagara shale: Lockport, N. Y.

Clinton: Ohio.

1901. *Deiphon forbesi*. van Ingen, School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

### **DICRANOPELTIS** Corda, 1847.

#### **Dicranopeltis arkansana** (van Ing.) .

1901. *Arges arkansana*. van Ing., School of Mines Quart., vol. 23, p. 61, fig. 19.

Silurian: St. Clair Spring, Independence Co., Ark.



**Dicranopeltis decipiens** (W. & M.).

1865. *Lichas breviceps* ? Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 30 (not *L. breviceps*. Hall, 1864).

Niagara: Bridgeport, Ill.

1865. *Lichas decipiens*. W. & M., Mem. Bost. Soc. Nat. Hist., vol. 1, p. 104, pl. 3, fig. 11.

Niagara: Bridgeport, Ill.

1867. *Lichas breviceps* ? Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 334; p. 377, pl. 21, figs. 12-14.

Niagara : Bridgeport, Ill.; Grafton, Wis.

1870. *Lichas breviceps* ? Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 424, pl. 21, figs. 12-14.

Niagara: Bridgeport, Ill.; Grafton, Wis.

1879. *Lichas emarginatus*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 199.

1907. *Dicranopeltis decipiens*. Weller, This Bulletin, p. 237, pl. 22, figs. 10-11.

Niagaran : Bridgeport, Hawthorn and near Lemont, Ill.

**Dicranopeltis nasuta** Weller.

1907. *Dicranopeltis nasuta*. Weller, This Bulletin, p. 240, pl. 22, figs. 5-7.

Niagaran : Milwaukee, Wis.

**Dicranopeltis telleri** Weller.

1907. *Dicranopeltis telleri*. Weller, This Bulletin, p. 241, pl. 22, figs. 8-9.

Niagaran : Milwaukee, Wis.

**ENCRINURUS** Emm., 1844.**Encrinurus americanus** Vogdes.

1866. *Encrinurus americanus*. Vogdes, Desc. New Crust. Clint. of Ga., etc., p. 1.

Clinton: Near Catoosa Station, Georgia.

1887. *Encrinurus americanus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 102.

Clinton: Georgia.

**Encrinurus egani** S. A. M.

1880. *Encrinurus egani*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. 2, p. 254, pl. 15, figs. 1-1b.

Niagara: Joliet, Ill.

1907. *Encrinurus egani*. Weller, This Bulletin, p. 257, pl. 24, figs. 8-11.

Niagaran: Joliet and near Lemont, Ill.

**Encrinurus indianensis** Kindle.

1904. *Encrinurus indianensis*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 482, pl. 24, figs. 14-15.

Niagara: Connor's Mill, Fishersburg, Huntington, Little Deer Creek and Wabash, Ind.

**Encrinurus nereus** Hall.

1865. *Encrinurus* \_\_\_\_\_. sp. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 30.

Niagara: Racine, Wis.

1867 *Encrinurus* \_\_\_\_\_. sp. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 334.

Niagara: Racine, Wis.

1867. *Encrinurus nereus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 375, pl. 21, fig. 15.

Niagara: Racine, Wis.

1870. *Encrinurus nereus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 425, pl. 21, fig. 15.

Niagara: Racine, Wis.

1878. *Cryptonymus nereus*. Vogdes, Monog. Gen. Zethus, Cybele etc., p. 24, pl. 3, fig. 17.

Niagara: Racine, Wis.

1887. *Encrinurus nereus*. Foerste, Bull. Sci. Lab. Den. Univ. vol. 2, p. 102.

Racine beds, Wisconsin.

### ***Encrinurus ornatus* H. & W.**

1852. *Cybele punctata*. Hall, Pal. N. Y. vol. 2, p. 297, pl. A66 figs. 1a-1k.

Clinton: Orleans and Niagara Cos., N. Y.

1875. *Encrinurus ornatus*. H. & W., Pal. Ohio, vol. 2, p. 154, pl. 6, fig. 16

Niagara: Eaton and Yellow Springs, Ohio.

1878. *Cryptonymus ornatus*. Vogdes, Monog. Gen. Zethus, Cybele, etc., p. 23.

Niagara: Eaton and Yellow Springs, Ohio; Medina, Reynolds Basin and Niagara, N. Y.

1887. *Encrinurus ornatus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 102.

Guelph limestone: Ohio.

1887. *Encrinurus punctatus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 103.

Clinton: New York.

1890. *Encrinurus punctatus*. Foerste, Proc. Bost. Soc. Nat. Hist., vol. 24, p. 269.

Clinton: Collinsville, Ala., Cumberland Gap, Tenn.

1901. *Encrinurus ornatus*. Grabau, Bull. N. Y. St. Mus., No. 45, vol. 9, p. 225, fig. 157.

Clinton: Niagara and Lockport, N. Y.

1901. *Encrinurus punctatus*. van Ingen, School of Mines Quart., vol. 23, p. 66.

Silurian: St. Clair Spring, Independence Co., Ark.

### ***Encrinurus punctatus* (various authors), see *Encrinurus ornatus* H. W., and *Encrinurus thresheri* Foerste.**

### ***Encrinurus thresheri* Foerste.**

1887. *Encrinurus thresheri*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 101, pl. 8, fig. 26.

Clinton: Ohio.

1895. *Encrinurus punctatus*. Foerste, Geol. Surv. Ohio, vol. 7, p. 531, pl. 27, fig. 26.

Clinton: Ohio, Hanover, Ind.

**Encrinurus tuberculifrons** Weller.

1907. *Encrinurus tuberculifrons*. Weller, This Bulletin, p. 259, pl. 24, figs. 12-13.

Niagaran : Near Joliet, Ill.

**HARPES** Goldfuss, 1839.**Harpes telleri** Weller.

1907. *Harpes telleri*. Weller, This Bulletin, p. 213, pl. 20, fig. 2.

Niagaran : Milwaukee, Wis.

**HEMICRYPTURUS.****Hemicrypturus clintoni** Van., see **Calymene clintoni** (Vanuxem) .**HOMALONOTUS** Koenig, 1825.**Homalonotus atlas** Castel., see **Homalonotus delphinocephalus** (Green).**Homalonotus dawsoni** Hall.

1860. *Homalonotus dawsoni*. Hall, Can. Nat. and Geol., vol. 5, p. 155, fig. 17.

Arisaig: Nova Scotia.

1868. *Homalonotus dawsoni*. Dawson, Acad. Geol. 2nd Ed., p. 606, fig. 214.

Arisaig.

**Homalonotus delphinocephalus** (Green).

1832. *Trimerus delphinocephalus*. Green, Monog. Tril. N. A., p. 82, fig. 1, plate.

Williamsville, Niagara Co., N. Y.

1834. *Trimerus delphinocephalus*. Harlan, Trans. Geol. Soc. Penn., vol. 1, pt. 1, p. 105.

Niagara Co., N. Y.

1834. *Brongniartia platycephala*. Harlan, Trans. Geol. Soc. Penn., vol. 1, pt. 1, p. 105.

Lockport, N. Y.

1843. *Homalonotus atlas*. Castel., Ess. Syst. Sil. l'Amer. Sept., p. 20, pl. 4, fig. 4.

Lockport, N. Y.

1843. *Homalonotus giganteus*. Castel., Ess. Syst. Sil. l'Amer. Sept., p. 20, pl. 3, fig. 1.

Lockport, N. Y.

1843. *Homalonotus herculaneus*. Castel., Ess.. Syst. Sil. l'Amer. Sept., p. 20, pl. 4, fig. 5.

Lockport, N. Y.

1843. *Homalonotus delphinocephalus*. Hall, Geol. N. Y., pt. 4, p. 103, fig. 34, tab. org. rem., 11, fig. 1.

Niagara: Lockport, Rochester, Sweden and Wolcott, N. Y.

1852. *Homalonotus delphinocephalus*. Hall, Pal. N. Y., vol. 2, p. 104, pl. 31, figs. 5a-5b; also p. 309, pl. 68, figs. 1-14.  
Clinton: Herkimer Co., N. Y.

Niagara: Lockport, Rochester and Wolcott, N. Y.

1856. *Homalonotus delphinocephalus*. Bill., Can. Nat. and Geol., vol. 1, p. 320.

Niagara: Canada.

1877. *Homalonotus delphinocephalus* ? Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 32, figs. 17-18.  
Niagara: Waldron, Ind.
1879. *Homalonotus delphinocephalus*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 187, pl. 32, figs. 17-18.  
Niagara: Waldron, Ind.
1882. *Homalonotus delphinocephalus*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 332, pl. 34, figs. 17-18.  
Niagara: Waldron, Ind.
1901. *Homalonotus delphinocephalus*. Grabau, Bull. N. Y. St. Mus., No. 45, vol. 9, p. 221, fig. 153.  
Rochester shale: Niagara, Lockport, etc., N. Y.

**Homalonotus giganteus** Castel., see **Homalonotus delphinocephalus** (Green).  
**Homalonotus herculaneus** Castel., see **Homalonotus delphinocephalus** (Green).

### ILLAENOIDES Weller, 1907.

#### **Illaeonoides triloba** Weller.

1907. *Illaeonoides triloba*. Weller, This Bulletin, p. 226, pl. 17, figs. 6-9, pl. 19, figs. 12-14.  
Niagaran: Bridgeport, Joliet, and near Lemont, Ill.

### ILLAENUS Dalm., 1826.

#### **Illaeenus aboynensis** Whiteaves.

1895. *Illaeenus aboynensis*. Whiteaves, Geol. Surv. Can., Pal. Foss., vol. 3, pt. 2, p. 108, pl. 15, figs. 7-8.  
Guelph: Aboyne, Ont.

#### **Illaeenus ambiguus** Foerste.

1885. *Illaeenus ambiguus*. Foerste, Bull. Sci. Lab. Den. Univ. vol. 1, p. 106, pl. 14, figs. 9a-9b, 10a-10c, 11.  
Clinton: near Dayton, Ohio.
1887. *Illaeenus ambiguus*. Foerste, 15th Ann. Rep. Geol. and Nat. Hist. Surv. Minn., p. 480, fig. 3, p. 478.  
Niagara: Miffintown, Penn.
1887. *Illaeenus ambiguus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 94.  
Clinton: Near Dayton, Ohio.
1890. *Illaeenus ambiguus*. Foerste, Proc. Bost. Soc. Nat. Hist. vol. 24, p. 267.  
Clinton: Hanover, Ind.
1895. *Illaeenus ambiguus*. Foerste, Geol. Surv. Ohio, vol. 7, p. 525, pl. 26, figs. 9a-9b, 10a-10c, 11.  
Clinton: Ohio; Hanover, Ind.

#### **Illaeenus armatus** Hall.

1865. *Illaeenus armatus*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 26, figs. 3-4.  
Niagara: Bridgeport, Ill., Grafton and Racine, Wis.
1865. *Illaeenus (Bumastus) worthenanus*. W. & M., Mem. Bost. Soc. Nat. Hist., vol. 1, p. 105.  
Niagara: Bridgeport, Ill.

1867. *Illiaenus armatus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 330, figs. 3-4, pl. 22, figs. 1-3.  
Niagara: Bridgeport, Ill., Grafton and Racine, Wis.
1870. *Illiaenus armatus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 418, figs. 8-9, pl. 22, figs. 1-3, pl. 25, fig. 22 also p. 433.  
Niagara: Bridgeport, Ill., Grafton and Racine, Wis.
1877. *Illiaenus armatus* ? Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 32, figs. 19-20.  
Niagara: Waldron, Ind.
1879. *Illiaenus armatus* ? Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 189, pl. 32, figs. 19-20.  
Niagara: Waldron, Ind.
1882. *Illiaenus armatus*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 335, pl. 34, figs. 19-20, pl. 33, fig. 12.  
Niagara: Waldron, Ind.
1904. *Illiaenus armatus*. Kindle, 28th Rep. Dep. Geol. and Nat. Res., Indiana, p. 479, pl. 22, fig. 6.  
Niagara : Georgetown and Wabash, Ind.
1907. *Illiaenus armatus*. Weller, This Bulletin, p. 222, pl. 18, figs. 4-6.  
Niagaran : Bridgeport and Lockport, Ill.

**Illiaenus barriensis** Hall, see **Illiaenus ioxus** Hall.

**Illiaenus chicagoensis** Weller.

1907. *Illiaenus chicagoensis*. Weller, This Bulletin, p. 220. pl. 16, figs. 10-12.  
Niagaran : Bridgeport, Ill.

**Illiaenus cornigerus** H. & W.

1872. *Illiaenus cornigerus*. H. & W., 24th Rep. N. Y. St. Mus. Nat. Hist., p. 186.  
Niagara: Falls of the Ohio.

**Illiaenus cuniculus** Hall.

1867. *Illiaenus cuniculus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 377, pl. 22, fig. 12.  
Niagara: Wauwatosa, Wis.
1870. *Illiaenus cuniculus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 421, pl. 22, fig. 12.  
Niagara: Wauwatosa, Wis.
1907. *Illiaenus cuniculus*. Weller, This Bulletin, p. 219, pl. 19, figs. 1-6.  
Niagaran : Hawthorn, Ill.

**Illiaenus danielsi** M. & G.

1893. *Illiaenus danielsi*. M. & G., Bull. No. 3, Ill. St. Mus. Nat. Hist., p. 76, pl. 7, figs. 3-5.  
Niagara: Bonfield, Ill.

**Illiaenus daytonensis** H. & W.

1875. *Illiaenus daytonensis*. H. & W., Pal. Ohio, vol. 2, p. 119, pl. 5, figs. 14-16.  
Clinton: Near Dayton, Ohio.

1885. *Illiaenus daytonensis*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 104, pl. 14, figs. 4a-4b, 6, 7a-7c.

Clinton: Near Dayton and at Fair Haven, Ohio.

1887. *Illiaenus daytonensis*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2; p. 93, pl. 8, figs. 6-7.

Clinton: Ohio.

1895. *Illiaenus daytonensis*. Foerste, Geol. Surv. Ohio, vol. 7, p. 525, pl. 26, figs. 4a-4b, 6, 7a-7c; pl. 27, figs. 6, 10a.

Clinton: Ohio; Lockport, N. Y.

### **Illiaenus graftonensis** M. & W.

1870. *Illiaenus (Bumastus) graftonensis*. M. & W., Proc. Acad. Nat. Sci. Phil., for 1870, p. 54.

Niagara: Grafton, Ill.

1875. *Illiaenus (Bumastus) graftonensis*. W. & M., Geol. Surv. Ill., vol. 7, p. 508, pl. 25, fig. 4.

Niagara: Grafton, Ill.

1907. *Illiaenus graftonensis*. Weller, This Bulletin, p. 223, pl. 16, figs. 4-6.

Niagara: Joliet, and near Lemont, Ill.

### **Illiaenus harrisi** Weller.

1907. *Illiaenus harrisi*. Weller, This Bulletin, p. 218, pl. 16, figs. 1-3.

Niagara: Bridgeport, Ill.

### **Illiaenus imperator** Hall.

1861. *Illiaenus imperator*. Hall, Rep. Prog. Geol. Surv. Wis., for 1860, p. 49.

Niagara: Racine, Wis.

1862. *Illiaenus imperator*. Hall, Geol. Surv. Wis., vol. 1, p. 433 (no description).

Niagara: Wisconsin.

1865. *Illiaenus imperator*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 28.

Niagara: Racine and Waukesha, Wis.

1867. *Illiaenus imperator*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 332, pl. 22, figs. 15-17; pl. 23, figs. 2-3.

Niagara: Wisconsin.

1870. *Illiaenus imperator*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 420, pl. 22, figs. 15-17; pl. 23, figs. 2-3.

Niagara: Wisconsin.

1882. *Illiaenus imperator*. Whitf., Geol. Wis., vol. 4, p. 306, pl. 21, figs. 4-5.

Niagara: Burlington, Wis.

1907. *Illiaenus imperator*. Weller, This Bulletin, p. 225, pl. 16, figs. 13-16.

Niagara: Joliet, Ill.

### **Illiaenus insignis** Hall.

1865. *Illiaenus insignis*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 27, figs. 5-6.

Niagara: Waukesha and Milwaukee, Wis.; Illinois.

1867. *Illiaenus insignis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 331, figs. 5-6, pl. 22, figs. 13-14.

Niagara Waukesha and Milwaukee, Wis.

1870. *Iliaenus insignis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 419, figs. 10-11, pl. 22, figs. 13-14.

Niagara: Waukesha and Milwaukee, Wis.

1882. *Iliaenus insignis*. Whitf., Geol. Wis., vol. 4, p. 305, pl. 21, figs. 6-10.

Niagara: Burlington, Racine, Waukesha, near Milwaukee and near Wauwatosa, Wis.

1887. *Iliaenus insignis*. Foerste, 15th Ann. Rep. Geol. and Nat. Hist. Surv. Minn., p. 481.

1895. *Iliaenus insignis*. Foerste, Geol. Surv. Ohio, vol. 7, p. 525, pl. 26, fig. 11.

Clinton: Ohio.

1904. *Iliaenus insignis*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 479, pl. 22, figs. 1-5.

Niagara: Connors Mill, Delphi, Georgetown, Fishersburg and Wabash, Ind.

1907. *Iliaenus insignis*. Weller, This Bulletin, p. 215, pl. 17, figs. 1-5.

Niagaran: Hawthorn, and Bridgeport, Ill.

***Iliaenus insignis* Meek, see *Iliaenus springfieldensis* Meek.**

***Iliaenus ioxus* Hall.**

1843. *Bumastus barriensis*. Hall, Geol. N. Y., pt. 4, p. 102, fig. 4, p. 101: tab. org. rem., 10, fig. 4, and 19 fig. 2.

Niagara: Rochester, N. Y.

1852. *Bumastus barriensis*. Hall, Pal. N. Y., vol. 2, p. 302, pl. 66, figs. 1-15.

Niagara: Lockport and Rochester, N. Y.

1860. *Bumastus barriensis*. Roemer, Sil. Faun. West. Tenn., p. 83, pl. 5, fig. 23.

Silurian: Tennessee.

1862. *Iliaenus (Bumastus) barriensis* ? Hall, Geol. Surv. Wis., vol. 1, p. 433 (no description).

Niagara: Milwaukee, Waukesha, Racine, etc., Wis.

1865. *Iliaenus (Bumastus) barriensis*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 28.

Niagara: Racine, Waukesha, Wauwatosa, etc., Wis.

1867. *Iliaenus (Bumastus) barriensis*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 332.

Niagara: Racine, Waukesha and Wauwatosa, Wis.

1867. *Iliaenus ioxus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 387, fig., pl. 22, figs. 4-11, pl. 23, fig. 1.

Niagara: Wisconsin.

1870. *Iliaenus (Bumastus) ioxus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 420, fig. 12, pl. 22, figs. 4-10.

Niagara: Racine, Waukesha and Wauwatosa, Wis.

1882. *Iliaenus (Bumastus) ioxus*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 335, pl. 38, figs. 13-14.

Niagara: Waldron, Ind.

1882. *Iliaenus ioxus*. Whitf., Geol. Wis., vol. 4, p. 304, pl. 21, figs. 11-12.

Niagara: Hartford, Pewaukee, Genesee, Racine, Greenfield, Waukesha, Grafton, and Sturgeon Bay, Wis.  
Guelph: Cedarville, Wis.

1883. *Illæenus (Bumastus) ioxus*. Hall, Trans. Albany Inst., vol. 10, p. 76.

Niagara: Waldron, Ind.

1890. *Illæenus ioxus*. Foerste, Proc. Bost. Soc. Nat. Hist., vol. 24, p. 268, pl. 5, fig. 20.

1901. *Illæenus ioxus*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

1901. *Illæenus ioxus*. Grabau, Bull. N. Y. St. Mus., No. 45, vol. 9, p. 223, fig. 154.

Rochester shale: Niagara, Lockport, etc., N. Y.

1904. *Illæenus ioxus*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, p. 480, pl. 22, fig. 7; pl. 23, fig. 3.

Niagara: Pendleton, Fishersburg, Helm's Mill and Connors Mill, Ind.

1907. *Illæenus ioxus*. Weller, This Bulletin, p. 222, pl. 18, figs. 1-3.

Niagaran: Joliet, Ill.

***Illæenus madisonianus* Whitf., see *Illæenus niagarensis* Whitf.**

***Illæenus niagarensis* Whitf.**

1880. *Illæenus niagarensis*. Whitf., Ann. Rep. Wis. Geol. Surv., for 1879, p. 68.

Niagara: Wisconsin.

1882. *Illæenus madisonianus*. Whitf., Geol. Wis., vol. 4, p. 307, pl. 20, figs. 8-9.

Niagara: Wisconsin.

1885. *Illæenus madisonianus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 106, pl. 14, figs. 1a-1b, 2a-2b.

Clinton: Dayton, Ohio.

1887. *Illæenus madisonianus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 93, pl. 8, figs. 8, 9, 10, 10a.

Clinton: Near Dayton, Ohio.

1895. *Illæenus madisonianus*. Foerste, Geol. Surv. Ohio, vol. 7, p. 526, pl. 26, figs. 1-2, varieties, pl. 27, figs. 7-10.

Clinton: Ohio.

1901. *Illæenus madisonianus*. van Ing., School of Mines Quart., vol. 23, p. 35 (no description).

Silurian: St. Clair Spring, Independence Co., Ark.

1907. *Illæenus niagarensis*. Weller, This Bulletin, p. 219, pl. 19, figs. 7-11.

Niagaran: Joliet and Lockport, Ill.

***Illæenus pterocephalus* Whitf.**

1878. *Illæenus pterocephalus*. Whitf., Ann. Rep. Wis. Geol. Surv., for 1877, p. 87.

Niagara: Pewaukee, Wis.

1882. *Illæenus pterocephalus*. Whitf., Geol. Wis., vol. 4, p. 309, pl. 20, figs. 10-12.

Niagara: Pewaukee, Wis.

***Illæenus springfieldensis* Meek.**

1873. *Illæenus (Bumastus) insignis* ? Meek, Pal. Ohio, vol. 1, p. 189, figs. A—B; pl. 15, figs. 5a—c.

Niagara: Springfield, Ohio.



1873. *Illaeus springfieldensis*. Meek, Pal. Ohio, vol. 1, p. 129.

**Illaeus transversalis** Weller.

1907. *Illaeus transversalis*. Weller, This Bulletin, p. 224, pl. 16, figs. 7-9.

Niagaran : Bridgeport, Ill.

**Illaeus worthenanus** W. & M., see **Illaeus armatus** Hall.

### **LICHAS** Dalm., 1826.

**Lichas boltoni** Hall, see **Arctinurus boltoni** (Rigsby).

**Lichas boltoni** var. **occidentalis** Hall, see **Arctinurus occidentalis** (Hall)

**Lichas breviceps** Hall, see **Metopolichas breviceps** (Hall) .

**Lichas breviceps?** Hall, see **Dicranopeltis decipiens** (W. & M.).

**Lichas byrnesanus** M. & G., see **Corydocephalus byrnesanus** (M. & G.).

**Lichas decipiens** W. & M., see **Dicranopeltis decipiens** (W. & M.).

**Lichas emarginatus** Hall, see **Dicranopeltis decipiens** (W. & M.).

**Lichas hanoverensis** M. & G. see **Corydocephalus phlyctainodes** (Green).

**Lichas nereus** Hall, see **Arctinurus nereus** (Hall).

**Lichas obvius** Hall, see **Arctinurus obvius** (Hall).

**Lichas ptyonurus** H. & C., see **Corydocephalus ptyonurus** (H. & C.).

**Lichas pugnax** W. & M., see **Metopolichas pugnax** (W. & M.).

### **METOPOLICHAS** Gürich, 1901.

**Metopolichas breviceps** (Hall).

1864. *Lichas breviceps*. Hall, Trans. Albany Inst., vol. 4, p. 222.  
Niagara: Waldron, Ind.

1875. *Lichas breviceps*. H. & W., Pal. Ohio, vol. 2, p. 156, pl. 6, fig. 17.

Niagara: Yellow Springs, Ohio.

1877. *Lichas breviceps*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (doc. ed.), pl. 34, fig. 1-7.

Niagara: Waldron, Ind.

1879. *Lichas breviceps*. Hall, 28th Rep. N. Y. St. Mus. Nat. Hist. (mus. ed.), p. 197, pl. 34, figs. 1-7.

Niagara: Waldron, Ind.

1882. *Lichas breviceps*. Hall, 11th Rep. Dep. Geol. and Nat. Hist., Indiana, p. 343, pl. 36, figs. 1-7.

Niagara: Waldron, Ind.

1885. *Lichas breviceps*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 112, pl. 13, figs. 26a—d.

Clinton: Near Dayton and at New Carlisle, Ohio.

1887. *Lichas breviceps*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 98, pl. 8, figs. 18-19.

Clinton: Near Dayton, Ohio.

1895. *Lichas breviceps*. Foerste, Geol. Surv. Ohio, vol. 7, p. 529 pl. 25, figs. 26a—e; pl. 27, figs. 18-19.

Clinton: Ohio.

**Metopolichas ferrisi** Weller.

1907. *Metopolichas ferrisi*. Weller, This Bulletin, p. 244, pl. 22, figs. 12-13.

Niagaran: Near Channahon, Will Co., Ill.

**Metopolichas pugnax** (W. & M.).

1865. *Lichas pugnax*. W. & M., Mem. Bost. Soc. Nat. Hist., vol. 1, p. 103, pl. 3, figs. 10a—c.

Niagara: Bridgeport, Ill.

1870. *Lichas pugnax*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 424, pl. 25, fig. 20; also p. 433.

Niagara: Bridgeport, Ill.

1907. *Metopolichas pugnax*. Weller, This Bulletin, p. 242, pl. 21, figs. 1-4.

Niagaran: Bridgeport, Ill.

**ODONTOPLEURA** Emm., 1839.**Odontopleura illinoiensis** Weller.

1907. *Odontopleura illinoiensis*. Weller, This Bulletin, p. 253, pl. 23, figs. 5-6.

Niagaran : Near Joliet, Ill.

**Odontopleura ortonii** (Foerste).

1885. *Acidaspis* \_\_\_\_\_. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 101, pl. 13, fig. 23.

Clinton: New Carlisle, Ohio.

1887. *Acidaspis ortonii*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 90, pl. 8, fig. 1.

Clinton: Near New Carlisle, Ohio.

1895. *Acidaspis ortonii*. Foerste, Geol. Surv. Ohio, vol. 7, p. 522, pl. 25, fig. 23, pl. 27, fig. 1.

Clinton: Ohio.

1901. *Odontopleura ortonii*. van Ing., School of Mines Quart., vol. 23, p. 39.

Silurian: St. Clair Spring, Independence Co., Ark.

1904. *Odontopleura ortonii*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 481, pl. 24, figs. 16-19.

Niagara: Georgetown and Pendleton, Ind.

**Odontopleura arkansana** van Ingen.

1901. *Odontopleura arkansana*. van Ing., School of Mines Quart., vol. 23, p. 40, fig. 9.

Silurian: St. Clair Spring, Independence Co., Ark.

**PHACOPS** Emm., 1839.**Phacops handwerki** Weller.

1907. *Phacops handwerki*. Weller, This Bulletin, p. 271, pl. 24, figs. 6-7.

Niagaran : Near Lemont, Ill.

**Phacops limulurus** (various authors), see **Dalmanites limulurus** (Green).**Phacops pulchellus** Foerste.

1885. *Arionellus* \_\_\_\_\_. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 114, pl. 14, fig. 3.

Clinton: Near Dayton, Ohio.

1887. *Phacops pulchellus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 99, pl. 8, figs. 4, 20, 21.

Clinton: Near Dayton, Ohio.

1890. *Phacops pulchellus*. Foerste, Proc. Bost. Soc. Nat. Hist. vol. 24, p. 268, pl. 6, figs. 20-21.

Clinton: Cumberland Gap, Tenn.

1895. *Phacops trisulcatus*. Foerste, Geol. Surv. Ohio, vol. 7, p. 529, pl. 26, fig. 3, pl. 27, figs. 4, 20, 21, pl. 31, figs. 20-21.

Clinton: Ohio.

1904. *Phacops cf. pulchellus*. Kindle, 28th Ann. Rep. Dec., Geol. and Nat. Res., Indiana, p. 484, pl. 24, figs. 9, 12.

Niagara: Connors Mill, Georgetown and Pendleton, Ind.

**Phacops trisulcatus** Foerste, see **Phacops pulchellus** Foerste.

**Phacops trisulcatus** Hall.

1843. *Calymene ? trisulcata*. Hall, Geol. N. Y., pt. 4, p. 74, fig. 9, p. 72; tab. org. rem. 8, fig. 9.

1852. *Phacops trisulcalus*. Hall, Pal. N. Y., vol. 2, p. 300, pl. 66, figs. 3a—b.

Clinton: New York.

**PLATYNOTUS** Con., 1838.

**Platynotus boltoni** Con., see **Arctinurus boltoni** (Bigsby).

**PARADOXIDES** Brong., 1822.

**Paradoxides boltoni** Green, see **Arctinurus boltoni** (Bigsby).

**PARADOXUS**

**Paradoxus boltoni** Bigsby, see **Arctinurus boltoni** (Bigsby).

**PROETUS** Stein., 1831.

**Proteus channahonensis** Weller.

1907. *Proteus channahonensis*. Weller, This Bulletin p. 228, pl. 20, figs. 6-7.

Niagaran: Near Channahon, Will Co., Ill.

**Proetus corrugatus** van Ing.

1901. *Proetus corrugatus*. van Ing., School of Mines Quart., vol. 23, p. 54, figs. 16-17.

Silurian: St. Clair Spring. Independence Co., Ark.

**Proetus corycaeus** (Conrad).

1842. *Asaphus corycaeus*. Conrad, Jour. Acad. Nat. Sci., 1st ser., vol. 8, pt. 2, p. 277, pl. 16, fig. 15.

Niagara shale: Lockport, N. Y.

1843. *Asaphus coryphaeus*. Hall, Geol. N. Y., pt. 4, tab. org. rem. 19; fig. 3.

Niagara: Lockport, N. Y.

1852. *Proetus corycaeus*. Hall, Pal. N. Y., vol. 2, p. 315, pl. 67, fig. 15.

Niagara: Lockport, N. Y.

**Proetus depressus** Weller.

1903. *Proetus ? depressus*. Weller, Pal. N. J., vol. 3, p. 249, pl. 22, fig. 27.

Decker Ferry: Nearpass Quarry, N. J.

**Proetus determinatus** Foerste.

1885. *Bathyrus* \_\_\_\_\_. Foerste, Bull. Sci. Lab. Den. Univ., vol. 1, p. 103, pl. 14, fig. 5.

Clinton: Near Dayton, Ohio.

1887. *Proetus determinatus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 91, pl. 8, figs. 2, 3, 3a.  
Clinton: Near Dayton, Ohio.
1895. *Proetus determinatus*. Foerste, Geol. Surv. Ohio, vol. 7, p. 523, pl. 26, fig. 5, pl. 27, figs. 2, 3, 3a.  
Clinton: Ohio.

**Proetus? handwerki** Weller.

1907. *Proetus ? handwerki*. Weller, This Bulletin, p. 229, pl. 20, figs. 8-9.  
Niagaran: Near Lemont, Ill.

**Proetus pachydermatus** Barrett.

1878. *Proetus pachydermatus*. Barrett, Am. Jour. Sci., 3rd ser., vol. 15, p. 371.  
Coralline limestone: Nearpass Cliff, N. J.
1903. *Proetus pachydermatus*. Weller, Pal. N. J., vol. 3, p. 248, pl. 22, figs. 16-21.  
Decker Ferry: Nearpass Quarry, N. J.

**Proetus spinosa** Weller.

1903. *Proetus ? spinosa*. Weller, Pal. N. J., vol. 3, p. 250, pl. 22, fig. 26.  
Decker Ferry: Nearpass Quarry, N. J.

**Proetus stokesii** Hall.

1852. *Proetus stokesii*. Hall, Pal. N. Y., vol. 2, p. 316, pl. 67, figs. 13-14.  
Niagara: Lockport, N. Y.

**Proetus subannulatus** van Ing.

1901. *Proetus subannulatus*. van Ing., School of Mines Quart., vol. 23, p. 57, fig. 18, p. 54.  
Silurian: St. Clair Spring, Independence Co., Ark.

## SPHAEREXOCHUS Beyr., 1845.

**Sphaerexochus minus** (various authors), see **Sphaerexochus romingeri** Hall.

**Sphaerexochus pisum** Foerste, see **Deiphon forbesi** Barr.

**Sphaerexochus romingeri** Hall.

1860. *Sphaerexochus mirus*. Roemer, Sil. Faun. West. Tenn. p. 81, pl. 5, fig. 20.  
Silurian: Tennessee.
1867. *Sphaerexochus romingeri*. Hall, Geol. Surv. Wis., vol. 1, p. 434 (no description).  
Niagara: Milwaukee and Waukesha, Wis.
1865. *Sphaerexochus mirus*. Hall, Adv. Sheets, 18th Rep. N. Y. St. Cab. Nat. Hist., p. 30.  
Niagara: Milwaukee, Racine, Waukesha and Greenfield, Wis.; Bridgeport, Ill.
1867. *Sphaerexochus mirus*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 334.  
Niagara: Milwaukee, Racine, Waukesha and Greenfield, Wis.; Bridgeport, Ill.

1867. *Sphaerexochus romingeri*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist., p. 375, pl. 21, figs. 4-7.  
Niagara: Wisconsin and Illinois.
1870. *Sphaerexochus romingeri*. Hall, 20th Rep. N. Y. St. Cab. Nat. Hist. (rev. ed.), p. 425, pl. 21, figs. 4-7.  
Niagara: Wisconsin and Illinois.
1875. *Sphaerexochus romingeri*. W. & M., Geol. Surv. Ill. vol. 7, p. 510, pl. 24, fig. 4.  
Niagara: Joliet, Ill.
1882. *Sphaerexochus romingeri*. Whitf., Geol. Wis., vol. 4, p. 311, pl. 21, figs. 1-3.  
Niagara: Racine and Waukesha, Wis.
1888. *Sphaerexochus mirus*. Foerste, Bull. Sci. Lab. Den. Univ., vol. 3, p. 121, pl. 13, fig. 6.  
Guelph: Cedarville, Ohio.
1901. *Sphaerexochus romingeri*. van Ing., School of Mines Quart. vol. 23, p. 35 (no description).  
Silurian: St. Clair Spring, Independence Co., Ark.
1904. *Sphaerexochus romingeri*. Kindle, 28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 483, pl. 22, figs. 8-9, 12-15.  
Niagara: Northern Indiana.
1907. *Sphaerexochus romingeri*. Weller, This Bulletin, p. 266, pl. 24, figs. 16-19.  
Niagaran: Bridgeport, Lemont, Romeo, Joliet, etc., Ill.

### **STAUROCEPHALUS** Barrande, 1846.

#### **Staurocephalus munchisoni** Barr.

1891. *Staurocephalus munchisoni*. van Ing. School of Mines Quart., vol. 23, p. 35 (no description).  
Silurian: St. Clair Spring, Independence Co., Ark.

#### **Staurocephalus obsoleta** Weller.

1907. *Staurocephalus obsoleta*. Weller, This Bulletin, p. 270, pl. 24, fig. 15.  
Niagaran: Near Lemont, Ill.

### **TRIMERUS** Green, 1832.

**Trimerus delphinocephalus** Green, see **Homalonotus delphinocephalus** (Green.)

# GLOSSARY

**Anterior**—Situated in front.

**Anterior limb of the facial suture**—That portion of the facial suture lying in front of the eye.

**Appendage**—A jointed process, two of which were borne by each segment of the trilobite body.

**Axial furrows**—Furrows or depressions bounding the axial or median longitudinal lobe of the trilobites; same as dorsal furrows.

**Axis**—The median longitudinal lobe of the trilobites.

**Carapace**—The hard shell covering the dorsal surface of the trilobite.

**Cephalon**—The head of trilobites

**Cheeks**—The two lateral portions of the head or cephalon of the trilobites, divided into fixed and free cheeks by the facial suture.

**Compound eyes**—Eyes commonly present upon the free cheeks of trilobites; they are made up of a large number of smaller facets.

**Cranidium**—The portion of the head or cephalon of the trilobite lying between the facial sutures, comprising the glabella and the fixed cheeks.

**Distal**—Away from the center.

**Dorsal**—Pertaining to the back.

**Dorsal furrows**—The furrows or depressions bounding the axial or medial longitudinal lobe of the trilobites; same as the axial furrows.

**Doublure**—The infolded margin of the trilobite test.

**Endopodite**—The inner of the two distal divisions of the typical crustacean appendage.

**Exopodite**—The outer of the two distal divisions of the the typical crustacean appendage.

**Eye lines**—A pair of raised lines reaching from the sides of the glabella to the compound eyes or the ocelli of some trilobites.

**Eye lobes**—Lobes of the fixed cheeks within the inner margins of the eyes. The palpebral lobes.

**Facial suture**—The suture in the head or cephalon of the trilobite separating the fixed from the free cheeks.

**Fixed cheek**—The portion of the cephalon or head of the trilobite lying between the glabella and the facial suture.

**Free cheek**—Lateral portion of the cephalon or head of the trilobite, lying between the facial suture and the lateral cephalic border.

**Furrows**—Grooves or narrow depressions.

**Genal angles**—The postero-lateral angles of the cephalon or head of the trilobites.

**Genal spines**—The posterior prolongation into spines of the genal angles of trilobites.

**Glabella**—The central or axial portion of the cephalon or head of trilobites.

**Gnathobase**—The basal joint of the ventral cephalic appendages of trilobites, modified to function as mouth parts.

**Holochroal eyes**—Compound eyes of the trilobites whose visual area is covered with a continuous horny integument.

**Hypostome**—The under lip of trilobites.

**Lateral**—Pertaining to or proceeding from the side.

**Lateral furrows**—The transverse furrows or grooves of the trilobite glabella, sometimes continuous across the glabella and sometimes greatly modified.

**Limb of pygidium**—The lateral areas of the trilobite pygidium exclusive of the axis.

**Marginal border**—The thickened or otherwise differentiated external border of the cephalon and pygidium of the trilobites.

**Marginal furrow**—The groove or depression lying just within the marginal border of the cephalon and pygidium of the trilobites.

**Neck segment**—The occipital segment.

**Ocelli**—The simple eyes present upon the fixed cheeks of some trilobites.

**Occipital furrow**—The posterior transverse groove or furrow of the glabella of trilobites, lying in front of the occipital segment.

**Occipital lobes**—Small, lateral lobes of the occipital segment present in some trilobites, which are morphologically different from the lateral lobes of the glabella.

**Occipital segment**—The posterior transverse segment of the trilobite glabella, lying between the posterior margin and the occipital furrow.

**Ocular ridges**—Ridges extending from near the anterior extremity of the glabella to the eyes in some trilobites.

**Ontogeny**—The life history of an individual organism.

**Palpebral lobes**—Lobes of the fixed cheeks within the inner margins of the eyes. The eye lobes.

**Plurae**—The two lateral longitudinal lobes of the trilobite, applied chiefly to the thoracic region and the pygidium.

**Post axial region**—The flattened area occupying the median portion of the pygidium of some trilobites, posterior to the elevated axis.

**Post cephalic margin**—The posterior margin of the head or cephalon.

**Posterior**—Situated behind.

**Posterior cheek furrow**—The marginal furrows or grooves present in some trilobites, which extend across the cheeks from the extremities of the occipital furrow of the glabella towards the genal angles.

**Posterior limb of facial suture**—That portion of the facial suture extending from the posterior extremity of the eye to the posterior or lateral margin of the cephalon.

**Protaspis**—The earliest recognized stage in the development of the trilobite test.

**Protopodite**—The basal portion of the typical crustacean appendage which supports distally the exopodite and the endopodite.

**Proximal**—Towards the center.

**Pygidium**—The tail or posterior region of the trilobite test.

**Schizochroal eyes**—Compound eyes of the trilobites in which the visual area is occupied by small openings for the separate facets.

**Test**—The hard outer covering of the trilobite.

**Thorax**—The central segmented region of the body of the trilobite.

**Ventral**—Pertaining to the under surface.

# DESCRIPTION OF GENERA AND SPECIES\*

## Order I. HYPOPARIA Beecher.

"Free cheeks forming a continuous marginal ventral plate of the cephalon, and in some forms also extending over the dorsal side at the genal angles. Sutures ventral, marginal or submarginal. Compound paired eyes absent; simple eyes may occur on each fixed cheek, singly or in pairs."—Beecher, Zittel-Eastman Text Book of Paleontology, p. 623.

### Family 1. HARPEDIDAE Barrande.

"Cephalon large, with a broad marginal expansion or limb; glabella short and prominent. Free cheeks ventral, continuous; suture marginal, following the outer edge of the limb. Paired simple eye-spots or ocelli, single or double, at the distal ends of well-marked eye-lines on the fixed cheeks, extending outward from the glabella. Thorax of from twenty-five to twenty-nine segments, with long grooved pleura. Pygidium (in *Harpes*) very small, composed of but three or four segments." Beecher, Zittel-Eastman Text Book of Paleontology, p. 625.

### Genus I. HARPES Goldfuss, 1839.

Cephalon large, horse-shoe shaped, strongly convex centrally with a broad flattened marginal expansion or limb which is produced posteriorly into long, flat, pointed genal spines. Glabella short, prominent, rounded or sub-truncate in front with a single pair of small lateral lobes posteriorly or a single transverse segment. Ocelli situated on the cheeks on either side of the glabella near its anterior end and connected with the glabella by raised eye-lines. Thorax conspicuously trilobate, thoracic segments twenty-five to twenty-nine, with long grooved pleura. Pygidium very small, composed of but three or four segments.

**Harpes telleri**, n. sp., pl. xx, fig. 2.

*Description.* Cephalon horse-shoe-shaped, with a broad, slightly concave marginal border or limb which passes posteriorly, with its entire width, into the prominent flat genal spines; the width of the limb at the sides and front of the head is equal, but the genal processes become gradually narrower

\*For. bibliography of the species described here, see the bibliographic list in the earlier portion of the Bulletin.



posteriorly. At the inner margin of the limb, a narrow, deeply impressed furrow separates it from the median convex portion of the head, laterally and anteriorly. The median portion rises vertically or is even slightly overhanging from the bottom of the bounding furrow to a height a little above the highest portion of the limb, the direction of the surface then changes abruptly to a gently convex curve nearly to the central elevated, axial portion or glabella which is surrounded by a slightly flattened area. The glabella is narrow and is abruptly elevated; posteriorly it is produced laterally into a pair of flattened, rounded lobes but little differentiated from the cheek surfaces. Upon each cheek a little back from the anterior extremity of the glabella and nearly half way between it and the furrow at the margin of the limb, is a small conical point-like ocellus slightly elevated above the general surface.

Thorax and pygidium unknown.

The dimensions of the type specimen are: width 19.5 mm., total length of head to genal extremities, approximately 24 mm., length of head along median line 12 mm., width of limb in front 5 mm., length of glabella 5.5 mm., width of glabella in front of basal lateral lobes 3.3 mm., distance between ocelli 5.5 mm.

*Remarks.* This species has not yet been observed within the Chicago area, the type specimens being from Wisconsin. It may, however, be looked for at Chicago. The species is the first representative of the genus which has been recognized in the Silurian faunas of America, although members of the genus are not uncommon in the European faunas of similar age. This American species more or less closely resembles several European forms, but it is characterized by the deep furrow at the inner margin of the limb.

The species is named in honor of Mr. E. E. Teller, of Milwaukee, Wisconsin, in whose collection the type specimen is preserved.

*Locality.* Milwaukee, Wis.

## **Order. II. OPISTHOPARIA** Beecher.

"Free cheeks generally separate, always bearing the genal angles. Facial sutures extending forward from the posterior part of the cephalon within the genal angles, and cutting the anterior margin separately, or more rarely uniting in front of the glabella. Compound paired holochroal eyes on free cheeks, and well developed in all but the most primitive family." -Beecher, Zittel-Eastman Text Book of Paleontology, p. 266.

**Family 2. ASAPHIDAE** Emmrich.

"Cephalon and pygidium well developed; glabella often obscurely limited. Free cheeks usually separate. Facial sutures extending forwards from the posterior edge of the cephalon within the genal angles, and cutting the lateral or anterior margins, occasionally uniting in front of the glabella. Eyes usually present, smooth, well developed, sometimes of very considerable size, even occupying the entire surface of the free cheeks. Thorax generally composed of eight or ten segments, but varying from five to ten. Pygidium large, often with wide doublure." -Beecher, Zittel-Eastman Text Book of Paleontology, p. 629.

**Genus 2. ILLAENUS** Dalman, 1826.

Complete body sub-elliptical in outline, the trilobation often nearly obsolete. Cephalon large, strongly convex smooth except for the slightly impressed dorsal furrows and the eyes. Eyes large, situated laterally and posterior to the mid-length of the head, their surfaces sometimes protruding beyond the lateral margins of the head. Anterior limb of the facial suture describing a gentle, slightly sigmoidal curve from the anterior margin of the cephalon to the eye; the posterior limb curving rather abruptly laterally from the posterior extremity of the eye to the post-cephalic margin. Free cheeks usually triangular. Thorax transversely convex, with nine or ten broad segments. Pygidium similar to the head in form and size, but usually less convex, the axis short and inconspicuous, sometimes obsolete.

**Illaeus insignis** Hall, pl. xvii, figs. 1-5.

*Description.* Cephalon large, parabolic in outline, strongly convex, the most prominent point on the median line between the centers of the eyes ; anterior and lateral margins slightly produced to form a narrow, thin, projecting, liplike border. Dorsal furrows moderately impressed, extending from the posterior margin of the head nearly to the anterior border where they terminate in shallow, pit-like depressions. Eyes large, sub-crescentiform, convex both vertically and horizontally, from two and a half to three times as long as high, situated a little obliquely, the posterior extremities being a little higher than the anterior, with the center of the eye a little below the center of the total height of the cephalon and a little nearer to the posterior than to the lateral border. Eye-lobes sloping

downward laterally from the dorsal furrows, the eyes moderately protuberant with a rather broad, shallow, rounded, ill-defined furrow beneath them upon the free cheeks. Free cheeks rather large, the posterior limb of the facial suture curving backward and downward from the posterior extremity of the eye, the anterior limb bending downward and forward with a slight concave curve and intersecting the margin almost directly in front of the eyes, it then follows the margin for a short distance towards the front before curving to the ventral side where it continues around the anterior extremity of the cephalon parallel with the margin and joins with the furrow from the opposite side.

Pygidium semi-elliptical in outline, strongly convex, greatest convexity near the middle, slightly flattened at the antero-lateral angles, with no indication of axial furrows or of a differentiated axis, but usually marked by a slight, median, longitudinal ridge from near the center to the posterior extremity.

The dimensions of a large and nearly perfect cephalon are: width 76 mm., length 35.5 mm., convexity 47 mm.; the dimensions of a pygidium are: length 56 mm., width 54 mm., convexity 25 mm.

*Remarks.* Specimens have been identified as *I. insignis*, and their relations discussed by four authors since the species was originally described by Hall. In the original description the character of the strongly marked, elongated dorsal furrows terminating in distinct rounded pits is considered as the most characteristic feature of the species, and this character is well shown in the specimens from Hawthorn, where the species occurs in great numbers almost to the exclusion of other members of the genus. These Hawthorn specimens, however, are constantly more pointed at the front of the cephalon than Hall's illustrations would indicate, but none of Hall's figures give a direct vertical view of his specimens, the cephalon being tipped backward so that the anterior margin would appear less pointed in the picture than it actually is in the specimen. The pygidia from Hawthorn which occur associated with the heads in about equal numbers, agree fairly well with the pygidia figured by Hall, but they are usually marked by a longitudinal median ridge which is not shown by Hall. The original pygidium used by Hall, however, is a small one, which may account for the absence of the rib.

In 1873, Meek<sup>1</sup> identified as *I. insignis* a species from the dolomitic Niagaran limestone at Springfield, Ohio. He pointed out several characters, however, in which the Ohio specimens failed to agree with Hall's original description and illustrations, and suggested that if they should prove to be distinct that the species might be known as *I. springfieldensis*. The Ohio species certainly is distinct from the *I. insignis* and the name *I. springfieldensis* is used to designate it in the bibliographic list in this Bulletin. The species does possess the elongate dorsal furrows terminating in pits, and also the lip-like margin of the cephalon of *I. insignis*, but the head is proportionally shorter and broader, and the eyes are more protuberant, the species approaching in these respects more closely to *I. harrisi* described in this Bulletin. The pygidium of *I. springfieldensis* is altogether different from that of *I. insignis*, as has been pointed out by Meek.

In his Wisconsin report Whitfield<sup>2</sup> has identified *I. insignis*, but the cephalon he illustrates lacks the strong, elongate dorsal furrows terminating in pits so characteristic of *I. insignis*, and the pygidium, although possessing the correct outline and the median ridge of *I. insignis*, has a very different profile, the greatest convexity being much more posterior in position than in the Hawthorn specimens. In all probability Whitfield's specimens represent an undescribed species of the genus.

Foerste's<sup>3</sup> identification of the species from the Clinton of Ohio is undoubtedly incorrect. His description is brief and without figures it is not possible to determine just what his species is. His description of the pygidium agrees more closely with Whitfield's Wisconsin form, than with the original *I. insignis*.

Kindle's<sup>4</sup> identification of the species from northern Indiana is not entirely satisfactory. Neither his illustration nor his description indicate fully the characters of his specimens; they possess the elongate dorsal furrows of the species terminating in pits, and seem to have the lip-like extension of the anterior margin, but the cephalon is less pointed in front than the Hawthorn specimens, and the pygidia are more rounded behind, and lack the median ridge.

*Locality.* Hawthorn, Illinois.

<sup>1</sup>Pal. Ohio, Vol. 1, p. 189.

<sup>2</sup>Geol. Wis., Vol. 4, p. 305.

<sup>3</sup>15th Ann. Rep. Geol. and Nat. Hist. Surv. Minn., p. 481; also Geol. Surv. Ohio, Vol. 7, p. 525.

<sup>4</sup>28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, 1903, p. 479.

***Illaeus harrisi***, n. sp., pl. xvi, figs. 1-3.

*Description.* Cephalon short, large, nearly semi-circular in outline, strongly convex, anterior and lateral margins slightly recurved to form a narrow, slightly projecting, lip-like border. Dorsal furrows rather strongly impressed, especially between the eyes, elongate, extending nearly to the anterior margin and terminating in pit-like depressions. Eyes large and prominent, sub-crescentiform in outline, about three times as long as high, convex both longitudinally and vertically, a little oblique, the posterior extremity being a little higher than the anterior, the centers situated above the middle of the total height of the cephalon and much nearer the posterior than the lateral margin; eye-lobes convex, extending in a nearly horizontal direction from the dorsal furrows; the eyes strongly protuberant with a conspicuous, broadly-rounded furrow beneath them upon the free cheeks. Free cheeks of moderate size, posterior limb of the facial suture curving backward and downward from the posterior extremity of the eye, the anterior limb extending downward and forward with a slightly concave curve and intersecting the anterior margin of the cephalon nearly in front of the eye, it then continues around the anterior border upon the ventral side just back of the margin, the sutures. from the opposite sides being continuous anteriorly.

The characters of the thorax and pygidium have not been observed.

The dimensions of a cephalon, the type specimen, are: length 32 mm., width 54.5 mm., convexity 29.5 mm.

*Remarks.* This is not a common species and has been observed only from Bridgeport in the Chicago area. In the elongate dorsal furrows and projecting liplike margin of the cephalon it resembles *I. insignis*, but it differs from that species in its much shorter cephalon and in its more strongly protuberant eyes and eye-lobes. In its proportions it more nearly resembles *I. chicagoensis*, but it may be distinguished from that species by its elongate dorsal furrows, its projecting border and its more prominent eyes. The nearest ally of *I. harrisi* seems to be *I. springfieldensis*, but the eyes are more prominent than in that species.

The name is given in honor of Mr. G. F. Harris, of Chicago, who collected the type specimen and presented it to the Walker Museum of the University of Chicago.

*Locality.* Bridgeport, Illinois.

***Illaeus cuniculus* Hall, pl. xix, figs. 1-6.**

*Description.* Cephalon elongate, longitudinally semi-elliptical in outline, depressed convex, anterior and lateral margins slightly produced to form a narrow, projecting, lip-like, marginal border. Dorsal furrows slightly impressed, short, not extending beyond the anterior extremities of the eyes. Eyes of moderate size, about three times as long as high, subcrescentiform in outline, convex longitudinally and vertically, situated nearly horizontally or with the anterior extremity slightly higher than the posterior, their centers above the middle of the total height of the cephalon, and much nearer the posterior than the lateral margins. Eye-lobes sloping downward from the dorsal furrows, the cheeks sloping much more abruptly from the outer margins of the eyes to the lateral border; just outside the outer margin of the eyes upon the free cheeks, is a slightly impressed, rounded furrow which is deeper and more conspicuous posteriorly. The posterior limb of the facial suture is very short, the anterior limb describes a slightly concave curve towards the front and intersects the margin almost directly in front of the eyes; the sutures from opposite sides are then continuous around the anterior extremity of the cephalon upon the ventral side just within the margin. Free cheeks rather large, longer than wide.

The thorax and pygidium to be associated with this cephalon have not been recognized.

The dimensions of a small but nearly complete cephalon are: length 20.5 mm., width 25 mm., convexity 11 mm., width between the eyes 21.5 mm. The dimensions of a large craniidium are: length 42.5 mm., width between the eyes 50 mm.

*Remarks.* This species may always be distinguished by its depressed cephalon, by its short dorsal furrows and by the posterior position of the eyes. In the short projecting lip-like anterior and lateral border of the cephalon, the species resembles *I. insignis* and *I. harrisi*, but the projection is less conspicuous upon *I. cuniculus* than upon either of the others. The species does not usually grow so large as *I. insignis*.

*Locality.* Hawthorn, Illinois.

***Illaeus niagarensis* Whitfield, pl. xix, figs. 7-11.**

*Description.* Entire body elliptical in outline, trilobation obsolete. Head and pygidium nearly equal in length, the thorax shorter than either. Cephalon sub-elliptical in outline, moderately convex, the dorsal furrows shallow and ill-defined

posteriorly, becoming stronger towards the front, they originate at the posterior margin back of the eyes and describe a curve above the eyes terminating in rounded pits about half way between the eyes and the anterior margin of the cephalon; below the eyes are other curved furrows originating near the base of the dorsal furrows with their anterior extremities nearly meeting those of the dorsal furrows, so that each eye is nearly surrounded by a sub-elliptical depression. The eyes are of moderate size and are situated back of the middle line of the head.

Thorax consisting of ten short segments with no indication of dorsal furrows.

Pygidium semi-elliptical in outline, not trilobite, strongly convex, a little flattened on top, becoming concave near the margin posteriorly so as to form an ill-defined concave border, which extends to the middle of the lateral margins and then disappears.

The dimensions of an imperfect specimen are: length 56 mm., width 32 mm., length of cephalon 20 mm., convexity of cephalon 13 mm., length of pygidium 21.5 mm.

*Remarks.* In the original description of this species by Whitfield, the specific name *niagarensis* was used, the reason for changing it to *madisonanus* in a later publication by the same author not being apparent, since the first name used had not been preoccupied. The entire description originally published for *I. niagarensis* was copied without change as the description of *I. madisonanus*. If the law of priority be followed it will be necessary to go back to the original specific designation of the species, *I. niagarensis*, as is done in the present Bulletin.

The head of this species with its elongate dorsal furrows terminating in rounded pits, somewhat resembles *I. insignis*, but it may always be distinguished from that species by the absence of the projecting lip-like marginal border in front and by its less convexity; the outline of the head is also different from that species, it being more nearly sub elliptical. The pygidia of the two species are very different, that of *I. niagarensis* may be recognized by the absence of the slight median ridge and by the concave border.

*Localities.* Joliet and Lockport, Illinois.

***Illænus chicagoensis***, n. sp., pl. xvi, figs. 10-12.

*Description.* Cranidium of medium size, semi-circular in outline, strongly convex, the convexity usually a little greater

than the length. Dorsal furrows well defined to points opposite the anterior extremities of the eyes, from there describing a gently sigmoidal curve and becoming much fainter or sometimes even obsolete, terminating in slight pits which are situated a little nearer the anterior margin than the anterior extremities of the eyes. Eye-lobes depressed below the median portion of the cephalon, convex, sloping laterally. Eyes oblique, describing less than a semi-circle, situated posteriorly, three or four times as long as high. Posterior limb of the facial suture directed obliquely outward, cutting the posterior margin about two-fifths the distance from the posterior extremity of the dorsal furrow to the genal angle; anterior limb twice as long as the posterior, describing a gentle outwardly convex curve, cutting the anterior margin nearly in front of the anterior extremities of the eyes. Free cheeks sub-triangular, longer than wide, depressed in a rounded furrow around the outer margin of the eyes and then gently convex to the lateral and posterior margins. Genal angles rounded.

The pygidium is depressed convex becoming slightly concave near the antero-lateral angles, much wider than long, the antero-lateral angles obtuse; posterior margin broadly and regularly rounded with a broad doublure; the anterior margin arcuate, slightly sinuate or notched on each side about half way between the center and the antero-lateral angles. Just within the anterior margin between the axial notches is a shallow rounded marginal furrow which becomes deeper and stronger laterally beyond the axial notches and then becomes obsolete before reaching the lateral margins. A slight median rib is usually present upon the surface, extending from the posterior margin towards the front, becoming obsolete before reaching the anterior margin.

The dimensions of a nearly perfect cephalon are: length 20.5 mm., width 39 mm., convexity 23 mm., width between the extremities of the eye-lobes 31 mm.

*Remarks.* This species has usually been confused with *I. ioxus*, but it differs from that species in its smaller size, the greater convexity of its cephalon, the longer dorsal furrows, in the more regularly rounded anterior margin of the cephalon and in the median rib of the pygidium. The species much more closely resembles *I. armatus*, differing from that species chiefly in the absence of the short genal spines and in its greater convexity. In general form the cephalon resembles that of *I. harrisi*, but the eyes are less protuberant, the dorsal furrows



much less deeply impressed in their anterior extremities beyond the eyes, and it lacks the lip-like extension of the anterior and lateral margins of that species. The cephalon differs from *I. graftonensis* in its greater convexity and in its more nearly semi-circular outline.

*Locality.* Bridgeport, Illinois.

***Illaeus armatus*** Hall, pl. xviii, figs. 4-6.

*Description.* Cephalon small and rather short, rather strongly convex, semi-circular in outline, the anterior and lateral margins rounded and not produced into a marginal lip-like extension. Dorsal furrows usually short and not produced beyond the anterior extremities of the eyes, but in some specimens they are continued anteriorly as faint depressions and terminate in faintly defined pits. Eyes prominent, their centers about the middle of the total height of the cephalon, situated near the posterior margin. Eye-lobes convex, extending in a nearly horizontal direction from the dorsal furrows. Beneath the outer border of each eye, upon the free cheeks, is a rather strong, rounded, depressed furrow. Free cheeks convex, longer than wide, the genal angles produced backward into rather short and blunt genal spines. Posterior limb of the facial suture very short, anterior limb sloping abruptly to the antero-lateral margin.

The dimensions of a complete cephalon are. length 13 mm., width 21 mm., convexity 9.5 mm., width of cranium between the eyes 17 mm.

*Remarks.* This species is usually of smaller size than other members of the genus in this fauna, although specimens frequently occur with greater dimensions than those of the specimen here illustrated. The species may always be recognized by its short genal spines.

*Localities.* Bridgeport and Lockport, Illinois.

***Illaeus ioxus*** Hall, pl. xviii, figs. 1-3.

*Description.* Cephalon attaining a large size, sub-semi-circular in outline, sub-truncate in front between the anterior extremities of the facial sutures, moderately convex, the smaller specimens more convex than the larger. Dorsal furrows rather broad, but not deeply impressed, becoming obsolete beyond the anterior extremities of the eyes. Eye-lobes depressed below the median portion of the cephalon, sloping with a convex curve from the dorsal furrows to the inner margins of the eyes.

Eyes situated posteriorly, oblique, the posterior extremity higher than the anterior, very narrow, the length in some large individuals being seven times the width, but in smaller specimens the proportionate length is less. Posterior limb of the facial suture directed obliquely outward and backward; anterior limb more than twice as long as the posterior, describing a slightly sigmoidal curve and cutting the anterior margin outside of a line drawn tangent to the surface of the eye. Free cheeks large, longer than wide, the genal angles rounded, the surface depressed below the outer margin of each eye, the space between the depressed surface and the lower margin of the eye being occupied by a conspicuous rounded ridge nearly as conspicuous as the eye itself and parallel with it.

The dimensions of a nearly perfect, large cephalon are: length 61 mm., width 105 mm., convexity 46 mm., width of cranium between the eyes 83 mm.

*Remarks.* This species, perhaps, has been more frequently identified from the American faunas of Niagaran age, than any other member of the genus, although some of these identifications are believed to be incorrect. The species was originally described from specimens occurring in the dolomitic Niagaran limestones of Wisconsin. The form commonly present in the Rochester shales of the New York Niagaran, which was originally referred to the European species *I. barriensis*, is now usually identified as *I. ioxus*, but such an identification is probably incorrect; besides this several forms in the dolomites of north-eastern Illinois and south-eastern Wisconsin have usually been named *I. ioxus* by collectors, which are really quite distinct species. The form described in this paper as *I. chicagoensis* has been commonly referred to this species, but the true *ioxus* is a much larger and less strongly convex species, with shorter dorsal furrows, with the anterior margin of its cephalon sub-truncate and with much narrower eyes beneath which are conspicuous ridges. The two most characteristic features of the species are its large size and the sub-truncate anterior margin.

*Localities.* Joliet, Illinois; Racine, Wisconsin.

***Iliaenus graftonensis*** M. & W., pl. xvi, figs. 4-6.

*Description.* Cephalon of medium size, short, moderately convex, transversely sub-elliptical in outline, somewhat contracted posteriorly, the greatest width nearly opposite the anterior extremities of the eyes, the dorsal surface rounding into the ventral surface along the lateral and anterior borders

Dorsal furrows short, rather broad and shallow, starting from pit-like depressions near the posterior margin of the cephalon, converging anteriorly and terminating nearly opposite the anterior extremities of the eyes but becoming less sharply defined anteriorly. Eye-lobes sloping gently from the dorsal furrows; eyes large, nearly horizontal in position, situated posteriorly, describing nearly a semi-circle, from four to six times as long as high; beneath the eyes the free cheeks are strongly depressed, the surface extending horizontally for nearly one-half their width, then curving abruptly downward and continuing to the lateral margin in a gently convex but nearly vertical curve. Posterior limb of the facial suture very short, anterior limb describing a sigmoidal curve and intersecting the anterior margin of the cephalon nearly in front of the eyes.

The thorax and pygidium of this species have not been recognized.

The dimensions of a nearly perfect cephalon are: length 26.5 mm., width 47 mm., convexity 19.5 mm., width of cranium between the eyes 38 mm.

*Remarks.* This species may always be distinguished from its associates by the sub-elliptical outline of the cephalon, by the posterior position of the eyes and by the conspicuous depression of the inner portion of the free cheeks just below the eyes.

*Localities.* Near Lemont and at Joliet, Illinois.

***Iliaenus transversalis***, n. sp., pl. xvi, figs. 7-9.

*Description.* Cephalon very short and broad, the convexity nearly equal to the length, and the breadth more than twice the length; anterior and lateral margins broadly rounded from the dorsal to the ventral sides. Dorsal furrows moderately impressed, short, scarcely reaching beyond the anterior margins of the eyes. Eye-lobes sloping slightly from the dorsal furrows, with a slightly convex surface. Eyes describing nearly a semi-circle, nearly horizontal in position, their posterior extremities approaching nearly to the posterior margin of the cephalon, their surface convexly curved vertically and about five times as long as high. At the outer margins of the eyes, upon the free cheeks, are slightly depressed, rounded furrows. Posterior limb of the facial suture short, directed obliquely outward toward the genal angles; anterior limb describing a slightly sigmoidal curve, cutting the anterior margin of the cephalon almost directly in front of the eyes. Free cheeks broad, their dor-

sal surface nearly horizontally directed near the margin of the eyes, then curving with a gentle convex curvature which becomes much more abrupt toward the anterior and posterior margins. Genal angles obtusely rounded.

Thorax and pygidium known not.

The dimensions of the most complete cephalon observed are: length 16 mm., width 40.5 mm., convexity 16 mm., width of cranidium between the eyes 25 mm.

*Remarks.* This species is easily distinguished from any of its associates by the very broad and short form of the cephalon, by its obtusely rounded genal angles, and by the broad rounding of the anterior and lateral margins which extends even to the posterior margin of the free cheeks. The species is not a common one, only a few incomplete heads having been observed.

*Locality.* Bridgeport, Illinois.

***Illaeus imperator*** Hall, pl. xvi, figs. 13-16.

*Description.* Cranidium strongly convex, wider than long, sub-elliptical in outline. Glabella broad and not defined in front; dorsal furrows strong, straight, slightly convergent anteriorly, less than one-half the length of the head. Cheeks convex, their surface depressed below the glabella posteriorly and becoming confluent with the general convex surface of the head anteriorly. Eye-lobes small and situated close to the posterior margin of the head, produced in a nearly horizontal direction. Form of the free cheeks unknown.

Pygidium sub-elliptical in outline, less convex than the head, twice as wide as long, trilobite anteriorly; the axial portion occupying about one-third of the entire width along the anterior margin, flattened on top, ill-defined posteriorly, the surface becoming confluent with the general convex surface of the pygidium at about the middle of its length.

Surface of both head and pygidium smooth. Thorax unknown.

The dimensions of a small cranidium are: length 20.5 mm., width between the eyes 37 mm., convexity 20 mm. The dimensions of a small but nearly perfect pygidium are: length 27.5 mm., width 55 mm., convexity 10.5 mm.

*Remarks.* The dimensions given above are in both cases those of small individuals. Larger specimens of heads attaining a length of 80 mm. or more are not infrequently met with, as well as pygidia of similar proportions, but these larger specimens are usually less well preserved.

This species does not occur in the higher beds of the Niagaran limestone of the Chicago area, being most common in certain beds at Joliet. It can be readily distinguished from all other species of the genus in the Chicago area by reason of its short and small eyes which are situated far back near the posterior border, the dorsal furrows of the head are also stronger than in most of the other species though in some they are much longer, and the trilobation of the head along the posterior margin is more strongly developed than in most of the species. The pygidium in its broad and short form, with the anterior trilobation, differs greatly from any of the other species. None of the other Niagaran species from the Chicago area, when perfectly preserved, could possibly be mistaken for this one, but the heads of *I. ioxus*, *I. graftonensis* with their short but strong dorsal furrows, are often difficult to distinguish from *I. imperator* when the free cheeks are removed and the eye-lobes injured. The species much more closely resembles some of the Ordovician members of the genus. It is really difficult to point out characters whereby it can be readily distinguished from *I. taurus* Hall of the Trenton limestone. The portions usually preserved are also much like but very much larger than the same portions of the little *Thaleops ovatus* of the Trenton limestone, but it is not likely that the Niagaran species possessed the divergent spine-like free cheeks of that species.

*Locality.* Joliet, Illinois.

### Genus 3. **ILLAENOIDES** n. gen.

Similar to *Illaenus*, but with the cephalon more strongly trilobed, with longer and stronger dorsal furrows. The eyes are small and situated much farther forward than in *Illaenus*. Thorax and pygidium as in *Illaenus*.

***Illaenoides triloba***, n. sp., pl. xvii, figs. 6-9; pl. xix, figs. 12-14.

*Description.* Cephalon small or of medium size, semi-elliptical in outline, rather strongly convex, anterior margin sometimes slightly recurved but never extended into a projecting lip-like border. Dorsal furrows broad and strong, giving to the head a conspicuous trilobate contour, extending nearly to the anterior margin where they gradually disappear; glabella smooth, convex; fixed cheeks convex, pointed at their posterolateral extremities, the surface exclusive of the compressed portion forming a pair of rather large, moderately convex, sub-elliptical lobes; eye-lobes very small and short, scarcely

separated from the general surface of the fixed cheeks, situated near the middle of the total length of the head; posterior limb of the facial suture nearly straight, intersecting the posterior margin near the rounded genal angle; anterior limb shorter than the posterior, intersecting the anterior margin nearly in front of the eyes. Free cheeks longer than wide, sub-triangular in outline, the surface convex except beneath the eyes where there is a rounded furrow nearly horizontal in direction.

Pygidium sub-elliptical in outline, moderately convex, with the greatest convexity near the center, axial furrows wanting, the lateral borders somewhat depressed.

The dimensions of a rather small but nearly perfect cephalon are: length 18 mm., width 26 mm., convexity 11 mm., width of cranium between the eyes 18.5 mm. The dimensions of a large pygidium are: length 29 mm., width 36 mm., greatest convexity 11 mm.

*Remarks.* This species is one of the rarer members of the fauna of the Chicago area, and can always be distinguished from members of the allied genus *Illæus* by its more strongly trilobed head, and its small eyes which are situated much farther forward than in any of the associated species of that genus.

*Localities.* Bridgeport, Joliet and Chicago Drainage Canal, near Lemont.

### Family 3. PROETIDAE Barrande .

"Cephalon about one-third of the whole animal; genal angles generally produced into spines; glabella tumid, with two lateral basal lobes defined by oblique furrows in front of the neck segment. Free cheeks large, separate. Sutures extending from the posterior margin inward to the eyes, and then forward, cutting the anterior margin separately. Eyes usually prominent, often large. Thorax of from eight to twenty-two free segments, with grooved pleura. Pygidium usually of many segments ; pleural and axial portions strongly grooved; margin entire or dentate."

-Beecher, Zittel-Eastman Text Book of Paleontology, p. 631.

### Genus 4. PROETUS Stein., 1831.

Complete body sub-elliptical in outline. Cephalon semi-circular, with a thickened marginal border; glabella well defined by the axial furrows, more or less strongly convex, narrower and rounded in front and usually extending to the inner side of the marginal border, lateral furrows obsolescent, basal lobes often present, occipital furrow well marked; eyes large and prominent, placed near the glabella. Thorax with well defined axis,

segments usually ten, with grooved pleura. Pygidium large, semi-circular, with a thickened marginal border, the axis well defined by the dorsal furrows, strongly elevated, distinctly segmented, and extending to the inner side of the marginal border, the pleural segments grooved.

**Proetus channahonensis** n. sp., pl. xx, figs. 6-7.

*Description.* Head moderately convex, semi-circular in outline, the length of the genal spines not determined. Glabella semi-elliptical in outline, depressed convex, defined by distinct but not deep dorsal furrows; first and second lateral furrows obsolete or faint, nearly transverse in direction and not continuous across the median portion of the glabella, posterior furrows not deeply impressed but always present, they originate at the dorsal furrows opposite the eyes and extend obliquely inward and backward with a slight convex curve nearly to the occipital furrow, their posterior extremities dividing the glabella into three nearly equal parts. Occipital furrow narrow, well-defined, including a pair of small subovate occipital lobes back of the postero-lateral angles of the glabella. Occipital segment rather narrow, its surface somewhat depressed below the glabella. Surface of the cheeks sloping with an even convex curve from the dorsal furrows laterally and anteriorly to within about one millimeter of the margin, outside this convex slope is an even, flattened, continuous marginal border which continues around the anterior margin of the head; along the posterior margin of each cheek is a strong posterior cheek furrow which is continuous from the dorsal furrow opposite the occipital furrow to the inner side of the marginal border. The anterior extremity of the glabella is separated from the marginal border by a narrow band which is continuous with the convex portion of the cheeks on either side. The fixed cheeks are narrow with the palpebral lobes rising directly from the dorsal furrows. Free cheeks broad, the eyes of moderate size, their surface describing about a semi-circle, their anterior extremities at about the mid-length of the glabella.

Pygidium semi-elliptical in outline, the axis strongly convex, bordered by the sharp dorsal furrows, occupying nearly one-third the entire width of the pygidium at the anterior margin, tapering posteriorly and terminating in a bluntly rounded extremity lying within the marginal border, divided into ten or eleven rounded annulations which become faint posteriorly. Surface of the pleura slightly flattened adjacent to the dorsal

furrows and then becoming moderately convex to the lateral margins, the thickened marginal border narrow and scarcely differentiated from the general surface, becoming a little wider posteriorly; each slope is divided into nine segments which become faint posteriorly, the last two being scarcely recognizable, the anterior-most segments extend entirely to the lateral margin, but the posterior ones terminate within the margin, in some specimens the broader segments are faintly grooved but in others no grooves can be detected.

The surface of both head and pygidium are smooth.

The dimensions of a nearly complete head with the exception of the genal spines and occipital segment are: width mm., length along median line 9 mm., width of glabella at occipital furrow 6.5 mm. The dimensions of a very perfect pygidium are: Width 10 mm., length 6.5 mm., width of axis at anterior margin 3 mm., length of axis 5.5 mm.

*Remarks.* This little trilobite has been observed only in a brown limestone near Channahon, Will County, Illinois, on the Des Plaines river, which is believed to be the lowest Niagaran horizon in the Chicago area. This horizon may be the same as the so-called Clinton of Ohio and Indiana. The species occurs only as detached, more or less fragmentary, heads and pygidia. This species most closely resembles *P. determinatus* Foerste, from the Ohio Clinton formation but it may be distinguished from that one by its more prominent glabella, especially in front, and by the more strongly impressed dorsal furrows in front of the glabella, and by the more strongly impressed lateral glabellar furrows.

*Locality.* Channahon, Will County, Illinois.

**Proetus ? handwerki**, n. sp., pl. xx, figs. 8-9.

*Description.* Head crescentiform in outline, its width between the extremities of the genal spines nearly three times its length along the median line. Glabella longitudinally semi-elliptical in outline, bounded by well-defined dorsal furrows truncated posteriorly, broadly rounded, strongly convex and protuberant in front; frontal lobe large and almost hemispherical; two pairs of lateral lobes may be detected but they are very small; of the two pairs of lateral furrows the first are very faint and short, being little more than slight indentations upon the lateral surfaces of the glabella at about the middle of its length, the second or posterior pair are a little more deeply impressed and extend from the dorsal furrow inward and then



backward towards the occipital furrow, nearly surrounding the very small posterior lateral lobes. Occipital furrow deep and strong, the anterior slope nearly vertical, the posterior slope less abrupt. Occipital segment narrow. Cheeks broad, their anterior slope nearly vertical from the eyes, the lateral slopes a little less abrupt, differentiated laterally and anteriorly into a well-defined marginal border which is separated from the glabella in front by a deep indentation beneath the protuberant frontal lobe; posterior margins marked by posterior cheek furrows which extend laterally from the occipital furrow. Fixed cheeks narrow; anterior limb of the facial suture nearly straight, the posterior limb curving outward and cutting the posterior margin of the head at about one-half the distance from the dorsal furrow to the lateral margin. Eye-lobes strongly and abruptly elevated from the dorsal furrow, their summits being nearly as high as the glabella. Fixed cheeks broad, the postero-lateral angles produced into genal spines whose entire length cannot be determined in the type specimen. Eyes rather large and very prominent, their surface describing nearly a semi-circle. Thorax and pygidium unknown.

The dimensions of the type specimen are: extreme width between the extremities of the genal spines 18 mm., length along median line 6 mm., width of glabella 5 mm.

*Remarks.* This species differs from all other members of the genus *Proetus* in its strongly convex and protuberant glabella. In some respects its characters are as near those of the genus *Cyphaspis* as *Proetus*, but the postero-lateral lobes of the glabella are less prominent than in that genus and there is a slight indication of a pair of lateral glabellar furrows in front of the posterior pair, which are never present in *Cyphaspis*. It is quite possible that the species should be considered as the type of an undescribed genus.

The species is named in honor of Mr. J. H. Handwerk of Joliet, who collected the specimen used as the type.

*Locality.* Chicago Drainage Canal near Lemont.

#### Genus 5. **CYPHASPIS** Burm., 1843.

Entire body sub-elliptical in outline. Cephalon semi-circular with a thickened marginal border which is produced posteriorly into genal spines. Glabella ovoid, strongly convex, with lateral furrows obsolete except the posterior pair which are deep and extend obliquely backward, connecting with the

occipital furrow and bounding on their outer sides a pair of small ovoid or pyriform basal glabellar lobes. Eyes small, situated near the glabella. Cheeks broad, connected anteriorly by a broad area between the anterior extremity of the glabella and the marginal border. Thorax with well-defined axis, segments 10 to 17 with grooved pleura. Pygidium small with a short axis and depressed pleura.

**Cyphaspis intermedia**, n. sp., pl. xx, figs. 3-5.

*Description.* Glabella semi-elliptical in outline, about three-fourths the length of the head, rounded in front and truncate behind, strongly convex longitudinally and transversely, surrounded laterally and anteriorly by a narrow but well defined dorsal furrow, the bottom of which is a little impressed below the inner margin of the cheeks; at the base of the glabella are a pair of small but well-defined lateral lobes which extend about half way up the sides of the glabella, they are separated from the main portion of the glabella by the posterior glabellar furrows which originate at the dorsal furrows about two-thirds the distance from the anterior extremity of the glabella to the occipital furrow, they describe a slight curve obliquely backward and inward, meeting the occipital furrow about half way between its middle point and the dorsal furrows; a second pair of lateral furrows are slightly impressed in the sides of the glabella just above the dorsal furrows, just in front of the mid-length of the glabella. The occipital furrow is narrow and shallow. The occipital segment is narrow and flat, its surface being considerably depressed below the glabella. The fixed cheeks extend nearly horizontally from the dorsal furrows into the palpebral lobes which lie opposite the outer extremities of the posterior glabellar furrows; in front and back of the palpebral lobes the surface slopes away rather abruptly from the dorsal furrows and is continuous around the anterior extremity of the glabella as a rather broad, slightly convex, sloping area between the dorsal furrow and the marginal border. Marginal border sharply defined and rather broad. Free cheeks not preserved in any of the specimens observed. Thorax and pygidium unknown. Entire surface of the cranidium covered with fine papillæ which are more crowded upon the cheeks, being nearly obsolete upon the marginal border.

The dimensions of the best preserved specimen, a cranidium, are: length 5 mm., width between the margins of the palpebral

lobes, approximately, 5.7 mm., length of glabella and occipital segment 4.25 mm., convexity of glabella 1.2 mm.

*Remarks.* This species is somewhat closely allied to *C. christyi* Hall, from Waldron, Indiana, but it may be distinguished from that species by the proportionately more elongate glabella, that portion of the head in *C. christyi* being described as one-half the length of the head, while in *C. intermedia* it is usually a little more than three-fourths of the total length of the head. The species differs from *C. clintonensis* Foerste, described from the Clinton formation of Ohio and elsewhere, in its proportionately shorter glabella, the glabella of that species reaching to the innerside of the marginal border. *C. intermedia*, therefore, occupies a position between *C. christyi* and *C. clintonensis* in respect to the proportionate length of the glabella.

*Locality.* Channahon, Will County, Illinois.

**Family 4. BRONTEIDAE** Barrande.

"Dorsal shield broadly elliptical. Cephalon less than one-third the entire length; glabella rapidly expanding in front, with faint indications of lobes. Free cheeks larger than the fixed. Facial sutures extending from the posterior margin just behind the eyes abruptly inward around the palpebral lobes, and then diverging and cutting the antero-lateral margins separately. Eyes crescentic. Thorax of ten segments, with ridged pleura. Pygidium longer than cephalon or thorax; axis very short, with radiating furrows extending from it across the broad limb toward the margin; doublure very wide; margin generally entire." Beecher, Zittel-Eastman Text Book of Paleontology, p. 631.

**Genus 6. BRONTEUS** Goldf., 1839.

Entire body broadly elliptical. Cephalon sub-semicircular; glabella rapidly expanding anteriorly, lateral furrows and lobes more or less obsolescent; eyes crescentic, situated back of the middle of the head, their outer margin usually being about in line with the lateral margins of the broad anterior portion of the glabella, free cheeks larger than the fixed. Thorax with ten segments. Pygidium very large, semi-circular or semi-elliptical in outline with entire margin, usually longer than the cephalon or thorax; axis very short with radiating furrows extending from its margin across the broad, flattened pleural surfaces toward the margin; doublure very wide.

**Bronteus acamas** Hall, pl. xx, fig. 1.

*Description.* Cephalon broad, depressed-convex, dorsal furrows extending a little more than one-third the entire length

of the head from the occipital furrow; frontal lobe of the glabella not differentiated laterally from the cheeks; a single pair of lateral glabellar furrows which at their inner extremities curve backward and join the occipital furrow, cut off a pair of sub-ovate lateral glabellar lobes; occipital furrow not continuous across the median portion of the glabella; occipital segment rather broad, with a pair of small occipital lobes back of the postern-lateral margins of the glabellar lobes; palpebral lobes comparatively broad and moderately elevated.

Pygidium sub-semielliptical or parabolic in outline, wider than long; axis short, sub-semielliptical in outline, with one or two transverse furrows near the anterior margin; upon each side the limb is marked by seven slightly elevated ribs which become obsolete before reaching the margin, the anterior ones usually have a slight sigmoidal curvature; the median rib or post-axial region is about twice as wide as the lateral ribs, through the first half of its length from the posterior margin of the axis it increases gradually in width, this increase becoming more rapid posteriorly until at the margin it is four or five times the width of its point of origin.

The dimensions of a nearly perfect Pygidium are: length 33.5 mm., width 41 mm.

*Remarks.* The heads of this species are rarely preserved, and the few specimens which have been observed are in a very fragmentary condition. The above description of this portion of the species has been taken from Hall's illustration and definition. The pygidia also are among the rarer members of the fauna of the Chicago area, although they are commonly much better preserved than the heads.

Winchell and Marcy's species *B. occasus* has been shown by Hall to be a synonym of *B. acamas*, although it would be impossible to determine this from the original description and illustration of the species. Hall, however, has refigured the type specimen of *B. occasus* and this corrected drawing shows it to be only a small specimen of *B. acamas*.

*Localities.* Bridgeport and Romeo.

#### Family 5. LICHADIDAE Barrande.

"Dorsal shield generally large and flat, with granulated test. Cephalon small, not more than one-fourth the entire length; genal angles spiniform. Free cheeks separate; sutures extending from the posterior margin obliquely inward to the eyes, and then almost directly forward, cutting the margin

separately. Glabella broad, with a large, often tumid central lobe, and from one to three side lobes. Eyes not large. Thorax with nine or ten segments, and grooved and falcate pleura. Pygidium large, flat, commonly with toothed or notched margin corresponding to the pleural grooves; doublure very broad." Beecher, Zittel-Eastman Text Book of Paleontology, p. 632.

In the subdivision of the family *Lichadidae* into generic groups, the work of F. R. Cowper Reed "Notes on the Genus *Lichas*" (Quart. Jour. Geol. Soc. London vol. 58, pp. 59-82, 1902), has been followed in the main, although his subgeneric divisions are given generic rank.

### Genus 7. **CORYDOCEPHALUS** Corda, 1847.

Cephalon broadly sub-triangular in outline, studded with tubercles, spinules or spines. Glabella well defined by the dorsal furrows, the median lobe protuberant in front and extending backward to the occipital furrow, second pair of lateral furrows obsolete, in consequence of which the first and second lateral glabellar lobes are confluent and form a single pair of large compound lobes, third pair of lateral glabellar lobes well defined, lying between the large compound anterior lobes and the occipital furrow, behind these area pair of basal or occipital lobes; cheeks broad, produced into a pair of curved genal spines which proceed from the sides outward and backward, the post-cephalic margin curving forward laterally to the bases of the spines. Pygidium with a thickened marginal border; axis strongly defined, elevated, connected with the marginal border posteriorly by a narrow post-axial ridge; the pleura with two segments, each of which is produced laterally into more or less elongate backwardly curving spines, the spines being produced across the surface of the pleura to the axis as strongly raised ridges.

**Corydocephalus phlyctainodes** (Green), pl. xxii, figs. 1-4.

*Description.* Cephalon, when viewed from above, semi-elliptical or obscurely sub-triangular in outline, very convex, strongly protuberant in front, deeply furrowed and covered with tubercles and spines. Dorsal furrows deep and strong anteriorly, becoming shallower behind, describing a convex curve from the frontal margin to the outer extremities of the third lateral furrows, then continued in a second convex curve around the extremities of the third lateral lobes, and a third slightly convex curve around the occipital lobes to the occipital furrow. Glabella sub-circular or broadly sub-ovate in outline,

very convex, the anterior and lateral slopes protuberant, Anterior lateral furrows broad and deep, sub-parallel from the frontal margin upward and backward, slightly converging posteriorly where they terminate in a depression between the inner extremities of the third lateral lobes. Second lateral furrows obsolete. Third lateral furrows as strong as the anterior pair, curving from the dorsal furrow slightly upward and backward, meeting the anterior pair in the depression between the third lateral lobes. Median lobe sub-ovate or sub-quadrangle in outline, occupying more than one-third of the entire surface of the glabella, broadest in front of the center where its width is from two-thirds to three-fourths its length, strongly convex and protuberant beyond the frontal margin anteriorly, the posterior slope gently convex and terminating in the depression between the inner extremities of the third lateral lobes; at its most anterior extension the median lobe bears two large spines which are produced forward in a nearly horizontal direction, slightly diverging from the base, on the dorsal surface in front of the middle are two other similar spines nearly in line with those in front, one of which is sometimes situated farther forward than the other, they are directed obliquely upward and forward. The compound anterior lateral lobes large, sub-triangular or irregularly sub-ovate in outline, acutely angular behind, the longer axis oblique to the median line of the cephalon, the surface somewhat depressed between the median lobe and the third lateral lobes. The third lateral lobes sub-elliptical or sub-ovate in outline, more than half the size of the anterior lobes, strongly convex, bearing a large spine on the outer extremity above the eye-lobe. Occipital lobes small, nearly flat, more or less indistinctly outlined, one-third or less than one-third the size of the third lateral lobes. Occipital furrow broad and deep in its central portion, dividing laterally, one division passing in front and the other behind the small occipital lobes, the divisions much narrower than the central portion. In front of the occipital furrow, between the inner extremities of the third lateral lobes, is a rather broad depression across which an indistinct ridge connects the inner extremities of these lobes. This ridge is surmounted by three tubercles, one situated medially and one at each end. Occipital segment strongly arched, broad, elevated along the posterior border which is produced into three strong spines directed obliquely backward and upward, its surface sloping toward the front. Fixed cheeks convex, narrow in front, becoming much broader posteriorly, with small

palpebral lobes. Eyes small, situated opposite the outer extremities of the third lateral lobes of the glabella, beneath the bases of the spines which surmount these lobes. Surface of the test thickly set with tubercles or short spines and by a smaller number of long spines which are themselves covered with tubercles. The most conspicuous of these spines are the two which extend forward from the anterior surface of the median glabellar lobe and the two which surmount the outer extremities of the third lateral lobes of the glabella; two somewhat smaller spines arise from the dorsal surface of the median glabellar lobe, and three from the posterior border of the occipital segment; these spines have usually been broken off but their bases may always be detected. Free cheeks not known.

Pygidium sub-semicircular in outline, with four long, marginal, tuberculate spines. The axis large and convex, narrowly sub-semielliptical in outline, with two annulations anteriorly, the first of which extends across the pleural slopes; occupying more than one-third the width of the pygidium anteriorly, the sides convex and converging posteriorly, the posterior extremity reaching nearly to the marginal border and connected with it by a narrow and short post-axial ridge. The pleural surfaces divided into two grooved segments, the posterior element of each segment being much elevated in a broadly rounded ridge extending from the dorsal furrow to the margin, and then being produced into one of the long, rounded, tapering, tuberculate spines which are longer than the body of the pygidium itself; the anterior pair of spines have a strong backward curvature until at their extremities they point in a posterior direction, the posterior pair are less strongly curved, from the margin of the pygidium they first diverge slightly, gradually curving until in their posterior half they slightly converge. The margin of the pygidium between the bases of the spines is differentiated as a broad, thickened, convex, marginal border.

The dimensions of a nearly perfect but rather small cranium are: length 23 mm., greatest width 24 mm., convexity 10 mm. The dimensions of a pygidium are length 15 mm., width 22.5 mm., approximate length of spines 20 mm.

*Remarks.* This species is a close ally of the Bohemian *C. palmata* Barr., but the cephalon of that species is not provided with the large spines of the American form, and the shape of the head is also different. The pygidia of the two species are also quite different, the four spines of the American species being much more elongate than the corresponding spines of the Bohemian

form, the two median spines are also lacking which are present in *C. palmata*. The specimens referred to a variety of this species by van Ingen, from the St. Clair limestone of Arkansas, differ from the typical form in the shape of the median lobe of the glabella and should doubtless be considered as a distinct species for which his varietal name *depauperata* may be used.

*Localities.* Joliet and Chicago Drainage Canal near Lemont.

Genus 8. **DICRANOPELTIS** Corda, 1847.

Cephalon tuberculate, sub-triangular in outline. Glabella well-defined by the dorsal or axial furrows, the median lobe more or less protuberant in front, extending backward to the occipital furrow. First lateral furrows extending backward to the occipital furrow, deep and strong anteriorly, sometimes becoming shallower and less well defined posteriorly. Second pair of lateral furrows obsolete so that the first and second lateral glabellar lobes are combined into a single pair of large compound lobes. Third pair of lateral lobes well defined, lying between the compound anterior lobes and the occipital furrow; behind these are a pair of basal or occipital lobes. Pygidium rather large, axis elevated with two annulations anteriorly and continued posteriorly in a flattened post-axial area; lateral lobes flattened, with three pairs of grooved pleura each with a free point, the posterior pair sometimes not completely marked off posteriorly from the post-axial area.

**Dicranopeltis decipiens** (W. & M.), pl. xxii, figs. 10-11.

*Description.* Cephalon very convex, sub-triangular in outline, produced laterally in rather strong, flattened spines which extend obliquely outward and backward, breadth between the extremities of the lateral spines more than twice the length. Glabella sub-pentagonal in outline, flattened on top posteriorly, the anterior slope strongly convex and slightly protuberant, lateral slopes gently convex. Dorsal furrows deep and strong anteriorly, becoming shallower posteriorly; describing a convex curve from the anterior margin to the junction with the third lateral glabellar furrows, beyond which they describe a slightly concave curve past the outer extremities of the third lateral and the occipital lobes to the occipital furrow. Median lobe of the glabella widest at the anterior margin where its breadth is nearly equal to that of the glabella at its mid-length, broadly convex in front, becoming narrower posteriorly where it forms a little less than the median third of the glabella at the junction



of the anterior or first with the third lateral glabellar furrows, back of which point it is partially coalescent with the third lateral lobes. Anterior lateral furrows deep and narrow, describing a concave curve from their anterior point of origin to their junction with the third lateral furrows, beyond which they are produced posteriorly to the occipital furrow as slight, ill-defined depressions. Second pair of glabellar furrows obsolete. Anterior lateral lobes large, compound, formed by the coalescence of the first and second pairs of lobes, strongly convex, irregularly sub-elliptical in outline, the longer axes directed obliquely forward. Third lateral furrows of the same depth and size as the anterior ones and continuous with them, being joined by a sharp curve; from this point to their junction with the dorsal furrow they are straight and are directed obliquely forward. Third lateral lobes quadrilateral in outline, length and breadth nearly equal, not sharply separated from the posterior portion of the median lobe, less than one-half the size of the compound anterior lobes. Occipital furrow broad, deep and straight across the posterior extremity of the median glabellar lobe, dividing on each side, the two divisions on each side bounding a pair of small, triangular occipital lobes situated back of the outer portions of the third lateral glabellar lobes. Occipital segment gently arched, broad in the center, becoming narrower laterally. Fixed cheeks convex, sloping both anteriorly and posteriorly, the palpebral lobes rather large, elevated, semi-circular. Free cheeks convex, sloping rather abruptly from the eyes, produced laterally from a point nearly opposite the eyes into flattened spines which are directed obliquely backward, and whose length is equal to about one-fourth of the width of the cephalon exclusive of the spines. The post-cephalic margin curving forward to the bases of the lateral spines.

Pygidium sub-semielliptical in outline; the axial portion occupying a little more than one-fourth of the entire width at the anterior margin, strongly convex anteriorly with two narrow, rounded annulations, back of which is a convex bulbous portion which becomes depressed near the center of the pygidium; back of the elevated portion the two axial furrows which bound the post-axial region converge to the posterior margin; the pleura are nearly flat and are divided into three, broad, grooved segments, all of which are produced on the margin into short, free points. The entire surface finely tuberculate.

The approximate dimensions of a large cephalon are: length 17 mm., width to ends of lateral spines 37.5 mm., width of

cranium between the eyes 18 mm. The dimensions of a pygidium are: length 12.5 mm., width 17.5 mm.

*Remarks.* This species, founded on the pygidium alone, was briefly described by Winchell and Marcy from Bridgeport. Their illustration was clearly incorrect, as pointed out by them in the "errata" of their paper, and really does not represent the essential characters of the species at all. The species, however, is not uncommon in the collections from Bridgeport, it is in fact the most common lichad which has been observed from that locality. Hall did not recognize Winchell and Marcy's species at all, but figured a pygidium (Rep. N. Y. St. Cab. Nat. Hist., pl. 21, fig. 14) from Bridgeport under the name *Lichas breviceps*, which he afterwards made the type of the new species *Lichas emarginatus*, which represents the species far better than Winchell and Marcy's original illustration. The head figured by Hall in the same place differs from anything that has been observed during the preparation of the present Bulletin, and doubtless belongs to another species. The head which is here associated with this species occurs about as commonly in the Bridgeport collections as the pygidia, and while these two portions of the body have never been found in such a position as to indicate that they originally belonged to the same individual, yet the heads and pygidia are not infrequently found closely associated. Occurring as they do in this manner, in approximately equal numbers, there seems to be no reasonable doubt as to the correctness of considering them to be parts of one species. If they do not belong to the same species, then there is no head for the common pygidium and no pygidium for the common head. The cephalon which is illustrated herewith on plate xxii, is not from Bridgeport, but from near Lemont, it differs from the Bridgeport specimens in its larger size and in the more sparse tuberculation of the surface, it has been used for illustration because it is more complete than any of the Bridgeport specimens in that it preserves one of the free cheeks.

The species which has recently been described as *Arges arkansana* by van Ingen, from the St. Clair limestone of Independence County, Arkansas, is very closely allied to this form from the Chicago area, and it is possibly not distinct from it. Both of these species, if they are distinct, are somewhat closely related to the Bohemian species *Lichas scabra* Beyr., the American and the European forms being co-generic.

*Localities.* Bridgeport, Hawthorn and Chicago Drainage Canal near Lemont.

**Dicranopeltis nasuta**, n. sp., p1. xxii, figs. 5-7.

*Description.* Cephalon triangular in outline, strongly convex, extended anteriorly into an acutely pointed projection. Dorsal furrows each describing a sigmoidal curve, strongly defined anteriorly, nearly obsolete along the outer margin of the third glabellar lobes. Glabella sub-pentagonal in outline, strongly convex, not sharply defined by the dorsal furrows, the general surface being continuous with that of the cheeks, anterior and antero-lateral slopes protuberant. Median lobe elongate, sub-pentagonal in outline, nearly twice as long as wide, the anterior half sub-conical and slightly compressed laterally, protuberant far beyond the anterior margin, the dorsal median line straight and sloping upward from the occipital furrow to the apex which is consequently elevated; in both specimens examined the apex is fractured and appears to have been produced into a slender spine. Anterior lateral lobes large, compound, sub-ovate in outline, completely surrounded by a deep and well-defined furrow, less than half their entire surface visible dorsally, their longer axes oblique to the median line of the cephalon, their length about twice their width, pointed at their inner extremities and rounded externally, strongly convex along their median line. Third lateral lobes trapezoidal in outline, nearly confluent with the median lobe within and scarcely defined by the dorsal furrow externally, the surface gently convex, completely visible dorsally, about one-half as large as the anterior lobes. First and third lateral furrows of the glabella strongly defined and confluent around the inner end of the anterior lateral lobes; the second lateral furrows obsolete. Occipital furrow well-defined, dividing at the postero-lateral angles of the median glabellar lobe, the two divisions on each side passing one in front and one behind the small triangular occipital lobes whose surface is slightly convex and completely visible in a dorsal view; the posterior branches of the occipital furrow are narrower and deeper than the median portion. Occipital segment narrow. Fixed cheeks narrow and linear from the lateral margins of the cephalon to the eyes, back of the eyes they are triangular with a gently convex surface which slopes laterally from the dorsal furrows with, a width about equaling the length of the third glabellar lobes, the anterior linear portion of the cheeks bends abruptly downward in front of the eyes to the margin of the cephalon; palpebral lobes very small. Free cheeks sub-quadrangular in outline,

nearly vertical in position, the surface gently convex above and slightly sinuous below, genal angles imperfect. Eyes small elliptical in outline, the longer axes oblique, the surface convex. Entire surface of the cephalon, except in the furrows and along the facial suture, covered uniformly with rounded tubercles of two sizes. Thorax and pygidium unknown.

The dimensions of the best preserved specimen which has been observed are: length of cephalon along median line 19 mm., greatest width of cephalon 24 mm., convexity 13.5 mm.

*Remarks.* This species has not yet been observed in the Chicago area. The types, which are the only specimens known, are from Milwaukee, Wisconsin, and were collected by Mr. E. E. Teller. The species is entirely different from any other American form.

*Locality.* Milwaukee, Wisconsin.

**Dicranopeltis telleri**, n. sp., pl. xxii, figs. 8-9.

*Description.* Cephalon sub-semielliptical in outline, bluntly rounded in front and slightly protuberant beyond the anterior margin. Dorsal furrows well defined along the outer margins of the anterior lateral glabellar lobes, much less well-defined adjacent to the third lateral lobes. Glabella sub-pentagonal in outline, broader than long, dorsal surface gently convex in front, general surface of the median and lateral lobes continuous, being indented only by the narrow but sharply defined furrows. Median lobe broadest at the anterior margin, becoming gradually narrower to the inner extremities of the anterior lateral lobes, where it becomes abruptly wider and then continues posteriorly to the occipital furrow with nearly parallel sides, anterior extremity very slightly protuberant beyond the margin. Anterior lateral lobes compound because of the obsolescence of the second lateral furrows, sub-ovate in outline, nearly twice as long as wide, nearly the whole of their surface visible dorsally. Third lateral lobes quadrilateral, rhombic-ovoid in outline, three-fifths as long as wide, about one-third as large as the anterior lobes, the longer sides and more acute extremities directed obliquely outward and forward, their entire surface visible dorsally. Occipital furrow narrow and deeply impressed, gently arched toward the front, dividing at the postero-lateral angles of the median glabellar lobe, the branches on either side passing one in front and one behind the small, triangular occipital lobes which are less than one-half as large as the third lateral glabellar lobes. Occipital segment

rather broad, gently arched between the lateral margins of the glabella, becoming narrower back of the occipital lobes. Fixed cheeks sub-triangular in outline, their surface gently convex and continuous with that of the glabella; palpebral lobes small, scarcely elevated. Entire dorsal surface, exclusive of the furrows, thickly set with small, low, rounded papillae, which are somewhat variable in size. Free cheeks, thorax and pygidium not preserved.

The dimensions of the type specimen are: length of cephalon along median line 15.5 mm., width of cranidium between the eyes 20.5 mm., greatest width of cranidium 23 mm., width of glabella at base 13.5 mm., width of glabella at middle of anterior lateral lobes 16.5 mm.

*Remarks.* This species like the last, has not been observed in the Chicago area, and is known only from Milwaukee, Wisconsin. The type specimens were collected by Mr. E. E. Teller; in whose honor the species is named, and are now in his collection.

*Locality.* Milwaukee, Wisconsin.

#### Genus 9. **METOPOLICHAS** Gürich, 1901.

Cephalon broadly sub-triangular, tuberculate. Glabella completely marked off by the dorsal or axial furrows; the second lateral glabellar furrows obsolete or indicated only by slight indentations of the first lateral furrows at the sides of the median glabellar lobe, and the third pair of lateral furrows also exhibiting a tendency to become obsolete, so that the third pair of lateral lobes are not sharply defined; basal or occipital lobes present. Cheeks broad, produced laterally into long, curved, genal spines which extend outward and backward, the post-cephalic margin curving forward to the bases of the spines. Pygidium with a rather short, elevated axis with one or two annulations, and a broad flattened post-axial area; lateral lobes flattened, with three pairs of grooved pleural segments, the two anterior pairs completely defined and with free points, the third pair not completely marked off from the post-axial area posteriorly and without free points.

**Metopolichas pugnax** (W. & M.), pl. xxi, figs. 1-4.

*Description.* Cephalon broadly sub-triangular in outline, the margin rounded in front, becoming sinuate on either side in front of the eyes in the anterior portion of the free cheeks, and then broadly convex to the extremities of the genal spines, the post-cephalic margin curving forward near the postero-

lateral angles of the cranium, the posterior margins of the free cheeks deeply sinuate; anterior and lateral margins depressed in a flat marginal border which is narrowest in front of the glabella. Glabella bordered by well-defined dorsal or axial furrows; the median lobe prominent and abruptly elevated in front, but not protuberant beyond the anterior cephalic margin, very broad in front, becoming rapidly narrower posteriorly; the anterior lateral furrows deeply impressed, continuous posteriorly with the third lateral furrows which curve outward toward the eye-lobes and terminate somewhat abruptly, not joining the occipital furrow; anterior lateral lobes compound, elliptical in outline, strongly convex, their posterior extremities higher than the surface of the median lobe between; second lateral furrows nearly obsolete, represented only by slight indentations in the inner margins of the anterior lateral lobes at about their mid-length; third lateral lobes ill-defined, coalescent with the anterior lobes externally in front, and partially coalescent with the median lobe internally. Occipital furrow well-defined, nearly straight in its central part, broadening laterally back of the third lateral glabellar lobes and including a pair of small, depressed, sub-triangular, ill-defined occipital lobes. Occipital segment convex, rather broad, becoming a little narrower laterally. Fixed cheeks prominent in the region opposite the eye-lobes, sloping abruptly to the front and somewhat less abruptly, with a convex surface, postero-laterally back of the eyes. Free cheeks large, depressed except near the eyes where the surface is rather abruptly elevated to the outer margins of the eyes, produced laterally opposite the eyes, into broad, flat spines which curve outward and backward, the post-cephalic margin curving forward to the bases of the spines.

Pygidium sub-elliptical in outline, its surface depressed-convex. Axis occupying more than one-third of the entire width of the Pygidium at its anterior margin, with a single distinct annulation anteriorly, bordered by distinct dorsal or axial furrows which continue posteriorly and bound a broad post-axial region which is strongly contracted near the middle of the Pygidium and which is coalescent posteriorly with the pleural segments on either side. The limb is divided into three pairs of broad, deeply grooved segments, the general surface is gently convex from the dorsal furrows through about one-half the width to the lateral margins, beyond this becoming slightly concave. The postero-lateral extremities of the two anterior pairs of pleural segments are produced somewhat into back-

wardly directed rounded free points, the posterior margin of the pygidium back of the second pleural segments is entire and describes nearly an arc of a circle. The surface of both head and pygidium are covered with scattered, rounded tubercles, somewhat variable in size.

The approximate dimensions of an incomplete cephalon are: length 44 mm., estimated width 118 mm., convexity 18 mm. The approximate dimensions of an incomplete pygidium are: length 80 mm., width 123 mm., width of axis at anterior margin 44 mm.

*Remarks.* This is perhaps the largest trilobite in the entire Niagaran fauna of the Chicago area. It is known only from incomplete heads and pygidia, although the more recent collections have afforded far better material for study than the original type specimens of Winchell and Marcy. In no case have specimens of the head and pygidium been observed in such position as to show that they belonged to the same individual, but the two portions of the body have frequently been found associated, and no other large heads or pygidia occur in the same beds. That the two portions of the body here described are really parts of one species can be assumed to be established beyond reasonable doubt. The large free cheek also which has been identified as a part of this species is an isolated specimen, but it occurs in the same beds with the heads and pygidia and can belong to no other known species. In the illustration of the cephalon of the species the free cheeks have been restored from the single specimen of that part of the head which has been observed.

*Locality.* Bridgeport.

**Metopolichas ferrisi**, n. sp., pl. xxii, figs. 12-13.

*Description.* Entire body sub-elliptical in outline. Cranium sub-triangular in outline, broadly rounded or sub-truncate in front. Glabella depressed-convex, about as wide as long, bordered laterally by shallow but well-defined dorsal furrows, narrowest a little back of a line joining the eyes, a little broader at the occipital segment than in front; median lobe occupying the entire width of the glabella in front, rapidly becoming narrower posteriorly until in line with the eyes it occupies only one-third the width of the glabella, posteriorly it is nearly confluent with the third lateral lobes externally; first lateral furrows strong and well-defined, curving from just back of the antero-lateral extremities of the median lobe

backward and inward, nearly parallel with the dorsal furrows to a point just back of the line joining the eyes, where they are continuous with the third lateral furrows, making a sharp turn outward and forward around the posterior extremities of the anterior lateral lobes, this inner well-defined portion of the third lateral furrows is short, being continued obliquely forward to the dorsal furrows as slight depressions which are sometimes almost obsolete; second lateral furrows represented by slight indentations of the anterior furrows into the inner sides of the anterior lateral lobes at about the middle of their length; anterior lateral lobes compound, sub-elliptical in outline, the longer axis a little more than twice the shorter, directed outward and forward, confluent posteriorly towards the dorsal furrow with the third lateral lobes; third lateral lobes much smaller than the anterior ones, ill-defined, separated from the median lobe by slight depressions only, which may sometimes be almost obsolete, from the anterior lateral lobes they are sharply separated within but laterally towards the dorsal furrows they are almost wholly confluent. Occipital furrow shallow, rather broad and ill-defined in the center, becoming more strongly defined laterally where it divides, the two divisions on each side surrounding a small, sub-ovate or slightly sub-rhombic occipital lobe. Occipital segment rather broad and flattened in the middle, a little narrower and more convex laterally. Fixed cheeks very narrow in front of the eyes, connected anteriorly around the front of the glabella by a narrow, flat, marginal border, back of the eyes they are much broader and are produced laterally, they are crossed near the posterior margin by the well-defined posterior cheek furrows, between the eyes and the posterior cheek furrows the surface is gently convex and slopes laterally and posteriorly. Palpebral lobes small, free cheeks unknown.

The thorax is represented in the specimens studied only by detached and broken segments. The axis is apparently broad and depressed-convex.

Pygidium depressed-convex, semi-elliptical in outline; the axis depressed, but little elevated above the surface of the pleura, occupying more than one-third of the entire width of the Pygidium anteriorly, crossed anteriorly by two transverse furrows, the first of which is much better defined and continuous across the entire width of the axis, the second one is less sharply defined, and is not continuous across the median portion of the axis, each of the two lateral portions curving



backward toward their inner extremities; posteriorly the axis is produced into a depressed post-axial region, the dorsal furrows converge posteriorly to about the middle of the pygidium where the axial region is about one-half its width at the anterior margin, from here the dorsal furrows diverge posteriorly, the axial region again becoming broader, the furrows do not reach the posterior margin of the pygidium so that the axial region is coalescent posteriorly with the pleural segments on either side. The pleura are divided into three pairs of broad grooved segments, the posterior-lateral angles of the two anterior pairs project slightly beyond the border of the pygidium as posteriorly pointing free points, between the free points of the second pleural segments the border is continuous.

The entire surface of the head, pygidium and thoracic segments is covered with small, more or less irregular, rounded papillae.

The dimensions of the best preserved cranidium observed are: length 17.5 mm., approximate width between the eyes 18.5 mm., width at posterior margin 30 mm., width of median lobe of glabella in front 13 mm. The best preserved pygidium has the following dimensions: length 16 mm., width 24 mm., width of axis at anterior margin 9 mm., width of axial region at narrowest point 4 mm.

*Remarks.* In general form this species resembles *M. breviceps* (Hall), from the Waldron shale of Indiana, but it differs from that species in several important characters. In the lobation of the glabella *M. ferrisi* is much more primitive than *M. breviceps*, the rudimentary, second, lateral, glabellar furrows being still discernible as slight indentations of the inner border of the compound anterior lateral lobes, while in *M. breviceps* these furrows have entirely disappeared; *M. ferrisi* also possesses a pair of third lateral glabellar lobes of some size, while in *M. breviceps* these have been nearly crowded out, the glabella assuming in this respect nearly the condition of the genus *Arctinurus*. These differences would suggest at once that *M. ferrisi* is the earlier species of the two, and this is the case, it having been observed only in the lowest Niagaran beds recognized in the Chicago area, while *M. breviceps* occurs in the Waldron shale, well up towards the summit of the Niagaran.

The species is named in honor of Mr. J. H. Ferris of Joliet, Illinois, who accompanied the writer at the time the type specimens were collected.

*Locality.* Near Channahon, Will County, Illinois.

Genus 10. **ARCTINURUS** Castelnau, 1843.

Glabella completely marked off by the dorsal furrows, the median lobe extending to the occipital furrow, the first and second lateral lobes combined and extending to the occipital furrow, the third lateral lobes squeezed out so as to be entirely absent; the second furrows obsolete or indicated by mere indentations of the first furrows; occipital lobes absent. Pygidium with one or two axial segments, the axis reaching about half way to the posterior border, the broad post-axial region with a sinuate or emarginate posterior margin; three pairs of grooved pleural segments, the two anterior pairs complete and with free points, the posterior pair complete or nearly complete.

**Arctinurus occidentalis** (Hall), pl. xx, figs. 10-12.

*Description.* Pygidium somewhat pentagonal or hexagonal in general outline, broader than long, the two lateral margins sub-parallel, the anterior margin nearly straight or sloping away laterally on each side of the axis. Axis strongly convex in the anterior third of its length, with one distinct annulation anteriorly and a second one a little less distinct and broader; the greatest elevation is at the anterior margin from which point the slope is abrupt laterally and more gentle posteriorly; back of the elevated portion is a depressed post-axial region; at the anterior margin the axis occupies about one-fourth the total width of the Pygidium, the axial furrows converge rapidly posteriorly to a point just back of the elevated portion where the width of the axial region is about one-third its width in front, from here the axial furrows are slightly divergent posteriorly to the posterior margin which is deeply sinuate between the posterior extremities of the axial furrows which terminate near the ends of a pair of strong, acute, backwardly pointing extensions of the Pygidium. Pleura nearly flat throughout the greater portion of their width, becoming slightly convex in proximity to the anterior elevated portion of the axis, divided into three pairs of deeply grooved segments which are strongly bent backward, their terminations being acutely angular free points, between which are deep emarginations, the terminations of the six angular pygidial extensions are directed posteriorly, the median pair, at either side of the posterior margin of the axial region, extend the farthest back, the terminations of the second pair are a little farther forward, and the outer pair a little in front of the second. The surface of the Pygidium is

studded with small, crowded, depressed, rounded tubercles. The cephalon and thorax are unknown.

The approximate dimensions of an average sized pygidium are: length 58 mm., width 68 mm., width of axis at anterior margin 17 mm.

*Remarks.* These pygidia are essentially like those which occur in the fauna of the Waldron shale of Indiana, which have always been considered as a variety of *A. boltoni* of the New York Niagaran fauna. The characters of all these western pygidia seem to be quite constant and to differ from the typical *A. boltoni* in having the pleural segments more elongate and directed more nearly in a posterior direction. Because of the constancy of these characters the form is here recognized as having full specific rank. Wherever it occurs the species is known almost wholly from the pygidium, and no heads certainly belonging to it have been observed in the Chicago area. However, one incomplete *lichad* glabella showing parts of a broad, moderately convex median lobe and a single pair of smaller lateral lobes, with the marginal border produced in front in a flat lip-like extension, perhaps represents the cephalic portion of this species.

The species *Lichas boltoni*, with which *M. occidentalis* is certainly co-generic, has been used at different times as the type for three different genera or sub-genera of the *Lichadidae*. Castelnau first used the name *Arctinurus* in 1843<sup>1</sup>, Conrad, however, had used the name *Platynotus* in 1838<sup>2</sup>, but this name had been preoccupied for a genus of insects, and so cannot be retained. In 1885 Schmidt proposed the name *Oncholichas*<sup>3</sup>, with *L. boltoni* as the type, associating with it certain Baltic Ordovician species which probably are not co-generic. In the present paper Castelnau's name is retained for the generic group.

*Locality.* Joliet and Bonfield, Illinois.

***Arctinurus chicagoensis***, n. sp., pl. xxiii, figs. 7-8; pl. xxii, fig. 14.

*Description.* The entire head not known. Glabella sub-pentagonal in outline, strongly convex, bounded laterally by strongly defined dorsal furrows; the median lobe extending from the anterior margin of the head to the occipital furrow, broadest in front where it occupies more than one-third the

<sup>1</sup>Ess. Syst. Sil. l'Amer. Sept., p. 21.

<sup>2</sup>Rep. N. Y. State Geol. Surv. for 1838, p. 118.

<sup>3</sup>Rev. Ost. Balt. Sil. Tril., pt. 2, Mem. Acad. Imp. Sci. St. Petersburg, Vol. xxxiii No. 1, p. 3.

entire width of the glabella, becoming regularly narrower backward to about the position of the line joining the eyes, where its width is less than half that at its anterior margin, and then slightly expanding again to the occipital furrow; first lateral furrows strongly defined and continuing backward on either side of the median lobe to the occipital furrow; lateral lobes not divided but consisting of a single pair which are compound, being formed by the coalescence of the first and second lateral lobes, they are large, each one being about two-thirds the size of the median lobe, convex, sub-elliptical in outline, their anterior extremities not as far forward as the median lobe, extending backward to the occipital furrow; second and third lateral furrows and the third lateral lobes obsolete. Occipital furrow broad, shallow and ill-defined back of the median glabellar lobe, becoming narrower and more sharply impressed laterally, not enclosing a pair of occipital lobes, apparently continuous laterally with the posterior cheek furrows. Occipital segment rather broad with parallel margins. The cheeks imperfectly preserved.

Pygidium sub-pentagonal in outline. The axis strongly convex from the anterior margin to near the middle where it is rather abruptly depressed and continues to the posterior margin as a depressed post-axial region in the same general plane with the pleural lobes, it is well defined by the dorsal furrows, and at its anterior extremity occupies about one-third the entire width of the Pygidium; the dorsal furrows converge posteriorly to a little back of the elevated portion of the axis, the axial region at this point being less than one-half its width anteriorly, from here the dorsal furrows continue posteriorly sub-parallel with each other becoming slightly divergent again toward their posterior extremities; anteriorly the axis has two distinct annulations with a third less distinct one, the third transverse furrow not being continuous across the median portion; the posterior margin of the axial region is broadly sinuate. The pleura nearly flat, divided into three pairs of broad, deeply grooved segments, the lateral extremities of the two anterior segments on each side are produced into bluntly rounded, backwardly directed free points, and between the angular extremities of the third pair of segments lies the sinuous posterior margin of the axial region. The entire surface of the head and Pygidium are covered with depressed, rounded and crowded papillae of rather large size. Thorax unknown.

The dimensions of the most complete head that has been studied are approximately: length 28.5 mm., width between the eyes 44 mm., greatest width of median glabellar lobe 20 mm., greatest width of glabella 34 mm. The approximate dimensions of an incomplete pygidium are: length 120 mm., width 76 mm., width of axis at anterior margin 26 mm.

*Remarks.* This species is best known from the pygidium, several examples of which, from the Van Horne Collection, have been under observation. The heads are less numerous than the pygidia and are even less perfectly preserved, only two examples have been seen, both upon a single specimen of limestone about 12x15 cm. in size where they are associated with two fairly well preserved pygidia, so that the correlation of the head and pygidium of the species is satisfactorily established. The large hypostome illustrated on plate xxii., figure 14, is associated with the parts of this species and is believed to belong here.

*Locality.* Hawthorn.

#### **Family 6. ACIDASPIDAE** Barrande.

"Dorsal shield spinose. Cephalon transversely semi-elliptical, quadrate or trapezoidal; genal angles spiniform. Glabella with one large median axial lobe and two or three lateral lobes. Free cheeks large, separate. Sutures extending from just within the genal angles abruptly inward to the eyes, and then forward, cutting the anterior margin each side of the glabella. Eyes small, often prominent. Thorax of eight to ten segments, with ridged pleura extended into hollow spines. Pygidium usually small, with spinous margin." -Beecher, Zittel-Eastman Text Book of Paleontology, p. 633.

#### **Genus 11. ACIDASPIS** Murch., 1839.

Entire body sub-elliptical in outline, strongly trilobite, the margin of the head, thorax and pygidium bordered with spines. Cephalon usually sub-crescentiform in outline, sometimes sub-truncate in front, the genal angles produced into spines. Median lobe of the glabella elongate, extending from near the anterior margin to the occipital furrow, with two or three pairs of lateral lobes which are successively larger from the anterior to the posterior, the occipital segment bearing a single median spine directed posteriorly. Thorax with nine or ten segments. Pygidium with two or three annulations.

**Acidaspis vanhornei**, n. sp. pl. xxiii, figs. 3-4.

*Description.* Cephalon, exclusive of the genal and median spines, sub-quadrangular in outline, the breadth nearly twice the length, the surface finely granular throughout. Glabella sub-cordate in outline, depressed-convex, a little wider than long, its greatest width at the middle of the posterior lateral lobes, the lateral lobes but little depressed below the median lobe. Median lobe elongate sub-ovate in outline, narrowly rounded in front, truncate behind, its greatest width about one-half its length, its anterior lateral expansions scarcely separated from the lateral lobes and coalescing with the ocular ridges. Anterior lateral lobes minute, scarcely separated from the anterior lateral expansions of the median lobe; the second lateral lobes much larger, their axes directed obliquely outward and forward; posterior lateral lobes about three times as large as the second pair, sub-ovate in outline, their longer axes nearly parallel with the median line of the cephalon; all the lobes coalescing with the median lobe internally. Anterior pair of lateral glabellar furrows scarcely distinguishable, second pair deeply impressed, slightly curved and directed obliquely forward and outward, extending to the dorsal furrow; third pair less strongly impressed than the second, the innermost strongly impressed portion directed nearly straight towards the front, the outer portion bent obliquely outward. Dorsal furrows describing a gentle curve, strongest at their junction with the occipital furrow, becoming faint anteriorly and scarcely recognizable in front of the second pair of glabellar furrows. Occipital furrow rather shallow back of the median glabellar lobe, becoming much more deeply impressed back of the lateral lobes. Occipital segment sub-lunate in outline, broadest in the middle, its lateral extremities becoming mere points just outside the posterior ends of the dorsal furrows, it bears a single, long, slender, median spine, which is directed backward with a slightly convex curve. Cheeks sub-rhomboidal in outline, moderately convex, their postero-lateral angles extended into slender, divergent, slightly curved genal spines, facial sutures not distinguishable. Eyes small, situated nearer the inner and posterior margins than the lateral and anterior, connected anteriorly by narrow but well-defined ocular ridges with the anterior lateral expansions of the median glabellar lobe; the inner area between the ocular ridge and the dorsal furrow is narrow, acutely pointed in front and strongly convex longitudin-

ally, especially opposite the eyes; the outer area of the cheeks is moderately convex, with a raised marginal border, which extends from the bases of the genal spines entirely around the lateral and anterior margins of the cephalon and which bears a fringe-like row of spines directed almost vertically downward from the margin; these spines are about twelve in number on each side, the longest ones being directly in front of the bases of the genal spines, the succeeding ones becoming regularly smaller until the most anterior ones in front of the anterior extremities of the ocular ridges are minute. Thorax and pygidium not known.

The dimensions of a nearly perfect cephalon are: length exclusive of the posterior median spine 10 mm., length, including the spine, 16.5 mm., width at base of genal spines 21 mm., width at extremities of genal spines 28 mm., width of glabella 10.5 mm., distance between the eyes 15 mm., convexity 8 mm.

*Remarks.* The specimen upon which the description of this species is based is included in the Van Horne Collection in the Walker Museum. In the illustration of the species on plate 23, the occipital and genal spines are drawn in outline, but in the specimen, while the casts of the spines themselves are broken off as shown in the drawing, their impressions in the matrix are fully preserved so that the outlines shown represent the exact form of the spines. The species is quite distinct from any other American member of the genus, but approaches most closely to the form identified by Van Ingen as *A. quinquespinosa* Salter-Lake, from the St. Clair limestone of Arkansas. The glabella of *A. vanhornei* is much like that of the Arkansas specimen, but the occipital spine is much more elongate and more slender and it lacks the four additional protuberances upon the posterior margin of the occipital segment. The marginal fringe of short spines in *A. vanhornei* is peculiar, in that the spines are directed ventrally in such a manner as to be wholly invisible in a dorsal view of the cephalon, only being seen in a lateral or anterior view of the head; other species with a similar marginal fringe of spines usually have them directed more or less laterally so that they may be clearly seen in a direct dorsal view of the cephalon.

*Locality.* Bridgeport.

Genus 12. **ODONTOPLEURA** Emmrich, 1839.

The members of this genus are essentially like those of *Acidaspis*, except in the ornamentation of the occipital segment

of the head, which is entirely smooth or is marked only with a small central tubercle, no median spine ever being present. The lateral lobes of the glabella are always distinct.

**Odontopleura illinoiensis**, n. sp., pl. xxiii, figs. 5-6.

*Description.* Cranium sub-quadrangular exclusive of the posterior portions of the fixed cheeks which are produced laterally. Glabella sub-cordate in outline, prominent, the lateral lobes but slightly depressed below the median lobe, a little wider than long, the greatest width at the middle of the posterior lateral lobes. Dorsal furrows well-defined, becoming deeper posteriorly where they join the occipital furrow. Median lobe of the glabella elongate, sub-quadrangular in outline, broadest in front, extending to the occipital furrow. Anterior lateral lobes obsolete; second lateral lobes strongly convex, sub-ovate in outline; posterior lateral lobes more than twice as large as the second pair, strongly convex, sub-elliptical in outline, their longer axes directed antero-laterally. Anterior glabellar furrows obsolete; second pair deeply impressed at their antero-lateral extremities, shallower within, curving posteriorly and joining the third pair of furrows; third pair of furrows more deeply impressed in their anterior half than the second, shallower behind where they curve posteriorly and join the occipital furrows as shallow rounded furrows. Occipital furrow broadly rounded and rather shallow in the middle, becoming deeply impressed back of the posterior glabellar lobes. Occipital segment without median tubercle or spine, the posterior margin nearly parallel with the occipital furrow, including a pair of small rather ill-defined occipital lobes lying behind the posterior glabellar lobes. Fixed cheeks in front of the eye-lobes divided into two regions by the ocular ridges which are prominent and describe a backward curve from opposite the antero-lateral angles of the median glabellar lobe to the eyes; the inner region of the fixed cheek is narrowly sub-crescentic in outline, lying opposite the lateral glabellar lobes, and rather strongly convex; the outer region is strongly depressed, extending in a nearly horizontal direction, sub-triangular in outline, becoming narrow posteriorly and also towards the median point of the anterior cephalic margin, being widest opposite the anterior lateral angles of the cranium. Eye-lobes small, not well preserved. The posterior portion of the fixed cheeks are produced laterally in elongate, slender points.



**Ceratocephala goniata** Warder, pl. xxiii, figs. 1-2.

*Description.* Cephalon short and strongly convex, transversely sub-elliptical in outline, the whole surface strongly tuberculate. Glabella broadly sub-ovate, moderately convex, scarcely defined by the dorsal furrows which follow a convex curve and become most strongly impressed at their junction with the occipital furrow, a little wider than long, the greatest width at about one-third its length from the occipital furrow, about three-fifths the entire width of the cephalon, its posterior margin nearly straight; median lobe well defined, elongate sub-ovate in outline, its length being equal to the total length of the glabella, slightly protuberant in front, its greatest width nearly two-thirds its length, its width in front three-fourths its width behind, a little more than one-half the width of the entire glabella, anterior lateral expansions slight and depressed, coalescing with the ocular ridges; lateral lobes depressed below the median lobe, the anterior pair almost obsolete and scarcely separated from the anterior lateral expansions of the median lobe; second lobes trapezoidal or sub-rhomboidal in outline, their longer axes directed obliquely outward and forward, coalescing laterally with the cheeks; third lateral lobes nearly twice the size of the second pair, sub-ovate in general outline, their apices directed obliquely outward and forward, sharply defined posteriorly by the occipital furrow, coalescing laterally with the cheeks. Anterior pair of lateral furrows scarcely distinguishable, second and third pairs deeply impressed at their inner extremities, directed obliquely outward and forward. Cheeks sub-quadrangular in outline, facial sutures not recognizable. Eyes small, situated near the center of the cheeks, connected anteriorly by a sharply defined, raised, rounded ocular ridge, with the anterior lateral expansions of the median glabellar lobe; posteriorly from the eyes a furrow faint at first but becoming strongly impressed posteriorly, follows a backward, upward and then inward curve to its junction with the occipital furrow. The inner portion of the cheeks, bounded anteriorly by the ocular ridge and posteriorly by the furrow, is convex, its surface being essentially a continuation of the surface of the lateral glabellar lobes, it is sub-ovate in outline, acutely pointed in front, and is divided longitudinally by a slight furrow which originates opposite the median glabellar furrow and extends backward with a slightly convex curve to a point nearly opposite the posterior glabellar furrow and then

curves rather abruptly inward, to meet the occipital furrow; this furrow is most strongly impressed posteriorly, but is fainter even than the dorsal furrow. The outer portion of the cheek is sub-lunate in outline and descends abruptly to the lateral margin, anteriorly it is concave below the ocular ridge, posteriorly its upper margin is elevated into a depressed ridge which is broader but less sharply defined than the ocular ridge, becoming more elevated as it approaches the base of the cheek spine; below this ridge the surface is concave, the lateral and posterior margins are raised into an elevated, rounded border, the posterior extremity is produced into the slender cheek spines which extend obliquely upward and outward. Occipital furrow broad and shallow across the median lobe of the glabella, becoming narrow and deeply impressed back of the posterior lateral lobes of the glabella. Median portion of the occipital segment broad and convex, bearing two slender, nearly erect and slightly diverging spines whose bases are widely separated; on the median line between the spine bases and situated a little in front of them is a strong rounded tubercle; the occipital lobes are strongly convex and rather sharply separated from the median portion, they are sub-oval in outline, with their longer axes directed obliquely backward and outward. Thorax and pygidium unknown.

The dimensions of a nearly perfect cephalon are: width 47 mm., length 17 mm., convexity 22.5 mm., width of glabella 26.5 mm., distance between eyes 35 mm., distance between bases of cheek spines 42.5 mm.

*Remarks.* The specimen of this species here illustrated is from the Van Horne Collection in the Walker Museum, and is the most complete cephalon which has been observed. The species has no near relative in other Silurian faunas of America, except *C. depauperata* van Ing., which is a much smaller form; it is somewhat closely allied to the Bohemian species *C. verneuili* (Barr.), but among other characters it lacks the marginal spines upon the cephalon which are present in that species. The name originally applied to the species by Warder was long overlooked and it was redescribed by Hall as *Acidaspis danae*, and by Winchell and Marcy as *Acidaspis ida*, the type specimens of both these authors being from Bridgeport, Illinois, while Warder's specimens were from near Springfield, Ohio. Dr. J. M. Clarke has shown that both these latter names are synonymous with Warder's earlier name.

*Localities.* Bridgeport and Hawthorn.

**Order III. PROPARIA** Beecher.

"Free cheeks not bearing the genal angles. Facial sutures extending from the lateral margins of the cephalon in front of the genal angles, inward and forward, cutting the anterior margin separately or uniting in front of the glabella. Compound paired eyes scarcely developed or sometimes absent in the most primitive family; well developed and schizochroal in the highest family." Beecher, Zittel-Eastman Text Book of Paleontology, p. 633.

**Family 7. ENCRINURIDAE** Linnarsson.

"Cephalon narrow, transverse. Fixed cheeks very large. Free cheeks long, narrow, separate, sometimes with a free rostral plate between the anterior extremities. Sutures extending from in front of the genal angles obliquely forward, and cutting the anterior margin in front of the glabella. Eyes very small or absent. Thorax of from nine to twelve segments, with ridged pleura. Pygidium generally composed of many segments; limb with strong ribs usually less in number than the annulations of the axis." Beecher, Zittel-Eastman Text Book of Paleontology, p. 634.

**Genus 14. ENCRINURUS** Emmrich, 1845.

Cephalon tuberculated, semi-elliptical in outline, the genal angles produced into spines or not; glabella prominent, pyriform, with three pairs of lateral furrows; free cheeks narrow, separated in front of the glabella by a small rostral plate; posterior limb of the facial sutures cutting the lateral margins just in front of the genal angles; eyes small, more or less elevated on conical prominences or slender stalks. Thorax with eleven segments. Pygidium subtriangular, the axis long with many more segments than are present upon the pleura.

**Encrinurus egani** S. A. M., pl. xxiv, figs. 8-11.

*Description.* Cephalon crescentiform with spreading genal spines. Glabella clavate, strongly convex, two and one-half times as broad in front as at the occipital furrow, produced anteriorly beyond the frontal margin of the head, the lateral margins concave, bounded laterally by deep, abrupt and rather broad dorsal furrows, covered with rather coarse rounded tubercles which are more or less regularly arranged in seven or eight transverse rows, the two posterior rows containing three or four tubercles each, while the anterior row may contain as many

as eight or more; lateral furrows nearly obsolete, represented by depressions which are scarcely distinguishable from the depressions between the rows of tubercles. Cheeks with a narrow, rounded, more or less indistinct marginal border which bears about three or four tubercles anteriorly on each side of the glabella, arranged in a row; produced posteriorly into genal spines of moderate length; the surface elevated just outside the dorsal furrow into sub-conical bases for the support of the long, slender, spreading peduncles which support the eyes, around the base of each eyestalk is a more or less irregular circle of tubercles similar to those upon the glabella with a few additional irregularly scattered tubercles upon the inner slopes of the cheeks toward the glabella, the remaining surface of the cheeks and the eye-stalks smooth.

Thorax with well defined axial furrows, the axis strongly convex, its width a little less than that of the pleural lobes, segments eleven in number, the next to the last one bearing a long slender spine which rises from the median line of the axis with a moderate backward curve.

Pygidium sub-triangular in outline, produced posteriorly into a long, slender, upwardly curving spine; axis strongly defined, the elevated portion extending into the posterior spine, it is divided into twenty or more short segments which in the casts are not continuous across the median region, and bears six tubercles along the median line, which lie between the inner extremities of the pleural ribs except the most anterior ones. Pleural lobes slightly flattened adjacent to the axial furrows, and then curving abruptly downward to the lateral margins, marked by seven pleural ribs which are stronger anteriorly, the last one or two often becoming nearly obsolete, each rib bears a well-defined tubercle just outside the dorsal furrow, and two or three of the median ribs often bear a second tubercle a short distance outside these first ones. A pair of tubercles is also present at the base of the caudal spine, with two or three additional indistinct ones along the lateral margins in front of the base of the posterior spine.

The dimensions of a small, more or less imperfect, but nearly complete specimen are: total length exclusive of the caudal spine 29 mm., length of cephalon 8 mm., length of thorax 12 mm., length of pygidium, exclusive of spine 9 mm. The dimensions of a nearly perfect cephalon are: length along median line 10 mm., distance between tips of genal spines 30 mm., greatest width of glabella 10.5 mm., width of axis at occipital

segment 6 mm., length of eye-stalks 7.5 mm. The dimensions of a large pygidium are: length, exclusive of caudal spine 29 mm., length of spine 10.5 mm., width at anterior margin 18 mm., width of axis anteriorly 7 mm.

*Remarks.* This species is remarkable by reason of its elongate eye-pedicles. These eye-stalks are difficult to preserve, and are usually broken off either before the creatures were fossilized or by the collectors of the specimens, this being the condition of the type specimen used by Miller in his description of the species. The thoracic and caudal spines are also usually broken. The species is so different from any of the other species of the genus that no comparison with any of them is necessary.

*Localities.* Joliet, and Chicago Drainage Canal near Le-mont.

**Encrinurus tuberculifrons**, n. sp., pl. xxiv, figs. 12-13.

*Description.* Cranidium sub-triangular in outline. The glabella prominent, sub-pyriform, not produced in front beyond the anterior margin, bounded by deep dorsal furrows; lateral furrows three on each side, not continuous across the median portion of the glabella, but the posterior pair more elongate than the others; occipital furrow well defined entirely across the posterior margin of the glabella, the occipital segment narrow; in front the glabella is bordered by a narrow flattened marginal border. Fixed cheeks strongly convex, with deep posterior cheek furrows originating at the dorsal furrows opposite the lateral extremities of the occipital furrow and extending nearly to the genal angles; genal angles apparently rounded and not produced into genal spines; eye-lobes small, elevated. Free cheeks not known. The entire surface of the glabella and fixed cheeks, except the occipital segment and the posterior marginal border of the cheeks, covered with small rounded tubercles, the anterior marginal border in front of the glabella bears a single continuous, symmetrically arranged row of tubercles similar to those upon the convex portion of the glabella.

Pygidium sub-triangular, wider than long, not produced posteriorly into a caudal spine. The axis prominent, bordered by well defined axial furrows, extending nearly to the posterior margin, its width in front about one-third the total width of the pygidium, marked by about fifteen annulations which become finer and less distinct posteriorly. Pleural lobes a little flattened adjacent to the axial furrows, the surface curv-

ing abruptly downward laterally to the margins, with six strong pleural ribs whose extremities are slightly produced, giving to the pygidium slightly serrate lateral margins.

The dimensions of the best preserved cranium which has been observed are: length along median line 6 mm., width between eyes 9.5 mm., width at posterior margin 13 mm. The dimensions of a pygidium are: length 5 mm., width 6 mm.

*Remarks.* This is a small species and is known only from more or less fragmentary crania and pygidia. These two portions of the body occur together at the only locality where the species has been observed, and since they are associated with no other members of the genus, it seems safe to consider them as portions of a single species. The species is especially characterized by the narrow, flattened anterior marginal border with its symmetrically arranged row of tubercles. The pygidium may be distinguished by reason of its proportionately greater width than is usual in the genus. The condition of preservation of all the specimens examined leaves it uncertain as to the presence of genal spines; these seem to be absent from the specimens studied but additional material may show that they were present.

*Locality.* Near Joliet.

#### **Family 8. CALYMENIDAE** Brongniart.

"Cephalon somewhat wider than long. Fixed cheeks large; genal angles rounded or produced into spines. Glabella narrowing anteriorly. Free cheeks long, separate, usually with a free plate between the anterior extremities. Sutures extending from just in front of the genal angles, converging anteriorly, and cutting the margins separately. Eyes small, facets numerous, visual surface seldom preserved. Thorax of thirteen segments, with grooved pleura. Pygidium of from six to fourteen segments; axis tapering." Beecher, Zittel-Eastman Text Book of Paleontology, p. 634.

#### **Genus 15. CALYMENE** Brongniart, 1822.

Complete body sub-oval in outline, possessing the power of complete enrollment; cephalon sub-crescentiform with thickened margin, genal angles usually rounded; glabella strongly convex, narrowed in front, with three pairs of deep lateral furrows; the occipital segment well defined; posterior limbs of the facial sutures originating just in front of the genal angles; free cheeks elongate, separate, usually with a free plate between

their anterior extremities in front of the glabella; eyes small; hypostome sub-quadrate, notched. Thorax with thirteen segments, the axis strongly convex and bounded by deep axial furrows; pleural lobes wider than the axis, bent down laterally. Pygidium distinctly marked off from the thorax, with six to eleven segments, the axis prominent and the margin entire.

**Calymene niagarensis** Hall, pl. xxiii, figs. 9-10.

*Description.* Body strongly trilobite, sub-ovate in outline, greatest breadth at the posterior margin of the cephalon, becoming gradually narrower to the junction of the thorax with the pygidium, then narrowing much more rapidly to the posterior extremity of the pygidium. When enrolled the body is sub-globular.

Cephalon short and broad, from two to two and one-half times as wide as long, anterior margin most sharply rounded in front, then sloping away to the genal angles with a gently convex curve. Glabella strongly convex, elevated above the cheeks, sharply defined by the deep dorsal furrows, broadest across the posterior lobes where it is as wide as long, broadly rounded or almost truncated in front; frontal lobe occupying less than one-third the length, transversely sub-semielliptical in outline; first lateral lobes very small, scarcely separated from the frontal lobe; second lateral lobes larger and node-like; posterior lobes much larger, forming a pair of conspicuous sub-globular nodes at the base of the glabella. Lateral furrows not extending across the median portion of the glabella; anterior pair scarcely recognizable, occupying only the lateral slopes of the glabella; second pair more conspicuous, rounded in the bottom, nearly confined to the lateral slopes of the glabella; posterior pair much broader and deeper, broadened or slightly bifurcate at their inner extremities, the stronger branch turning backward toward the occipital furrow, the smaller branch turning slightly forward, between these two divisions of the furrow is a slight node upon the side of the glabella. Occipital furrow arching forward in the center, rather broad and rounded in the bottom in the middle, becoming narrower and more deeply impressed back of the posterior glabellar lobes, extended as a broad posterior cheek furrow across the posterior portion of the cheeks. Occipital segment broadest in the middle, becoming narrower back of the posterior glabellar lobes. Cheeks strongly convex with rounded, lateral, marginal borders, and sharp, posterior, marginal borders. Just within the raised marginal borders

laterally and posteriorly, are shallow, rounded, concave furrows. Eyes small, situated opposite the second lateral glabellar lobes.

Thorax consisting of thirteen segments, the length two to two and one-half times that of the cephalon, strongly trilobed, the axis about two-fifths the entire width, the pleural lobes flattened on top for about one-third their width, then curving abruptly to the lateral margins. The segments arched forward on the axis, each one bearing a distinct, rounded node on either side just within the dorsal furrows. The pleura of each segment marked by a broad, deep, rounded furrow which originates at the axial furrow and extends two-thirds or more of their length, becoming shallower and narrower distally and terminating on the flattened distal portion of the segment as a slender groove with a slight forward curvature.

Pygidium irregularly sub-pentagonal in outline, strongly trilobed. The axis tapering posteriorly with an obtusely rounded extremity and terminating within the marginal border, marked by six or seven annulations. Pleural lobes with a flattened area in front, adjacent to the dorsal furrows, which tapers posteriorly and becomes obsolete before reaching the end of the axial lobe, outside this flattened area the surface slopes abruptly to the lateral margins; marked by four or five segments with no longitudinal depressions, which reach half way or less than half way from the dorsal furrows to the margins; anterior lateral angles abruptly flattened, lateral margins raised in a rounded marginal border which becomes narrower posteriorly.

The dimensions of a small, complete individual are: length 36 mm., greatest width across the posterior margin of the head 23 mm., length of head 10 mm., length of thorax 27 mm., length of pygidium 12.5 mm., width of pygidium 12.5 mm.

*Remarks.* The discrepancy between the sums of the lengths of the three regions of the specimen whose dimensions are given above and the total length of the body, is due to the fact that in the total dimension no account is taken of the curvature of the dorsal surface of the body, while in taking the three separate dimensions the measurements were made along their median dorsal lines.

This species is by far the commonest trilobite in the Niagaran fauna of the Chicago area, and seems to be present in all horizons. It is very commonly found with all portions of the body, head, thorax and pygidium together, a condition of preservation which is extremely rare in all other species of the fauna.



*Localities.* Bridgeport, Hawthorn, Joliet, near Lemont, etc., etc.

**Family 9. CHEIRURIDAE** Salter.

"Glabella well defined. Free cheeks small, sometimes much reduced. Sutures extending from in front of the genal angles inward to the eyes, and then obliquely forward, cutting the anterior margin in front and on each side of the glabella. Eyes usually small. Thorax of from nine to eighteen segments, generally eleven; pleura often extended into hollow spines. Pygidium small, with from three to five segments; pleural elements commonly produced into spines." Beecher, Zittel-Eastman Text Book of Paleontology, p. 635.

**Genus 16. CERAURUS** Green, 1832.

Entire body sub-ovate in outline. Cephalon sub-semicircular or sub-semielliptical in outline, the genal angles produced into spines; glabella strongly convex, broadest in front, with three pairs of deep, lateral furrows; posterior limbs of the facial sutures cutting the lateral margins well in front of the genal angles; eyes small. Thorax usually with eleven segments, rarely nine to thirteen; axis prominent, narrower than the pleura, bounded by strong axial furrows. Pygidium small, the pleural segments produced into points or spines.

**Ceraurus niagarensis** Hall, pl. xxiv, figs. 20-21.

*Description.* Head sub-circular in outline with slender genal spines projecting straight backward. Glabella moderately convex, broadest in front, limited by well-defined, impressed dorsal furrows, its posterior margin occupying one-third of the total width of the head; frontal lobe transversely sub-elliptical, occupying less than one-half of the entire glabella, first lateral lobes small, sub-quadrangular; second lateral lobes larger than the first, narrowest at the dorsal furrow; third lateral lobes sub-triangular, entirely isolated; first lateral furrows strong and deep, rounded in the bottom, directed a little backward at their inner extremities, extending less than half way from the dorsal furrow to the median line of the glabella; second lateral furrows similar to the first but a little shorter, their direction nearly transverse; third lateral furrows strong and deep, continuous across the glabella, shallower in the median portion and arching backward to become confluent with the occipital furrow; occipital furrow about equaling in strength the lateral furrows of the glabella, its median portion shallower and arching

forward to become confluent with the third lateral furrows; occipital segment broadest in the middle, its surface slightly higher than that of the glabella on the median line. Cheeks convex, depressed below the glabella, marked laterally by conspicuous marginal furrows continuous with the posterior cheek furrows which extend to the dorsal furrows, their terminations being opposite the extremities of the occipital furrows; the convex lateral and posterior marginal borders are produced backward, where they become confluent, into the slender genal spines; palpebral lobes small, eyes and free cheeks not observed. The surface of the cheeks lying between the bounding furrows is pitted, the pits being more or less rounded in shape and crowded together.

Pygidium broad and short, the axis wedge-shaped with three annulations and a narrow, posterior, median extension which is produced a little beyond the posterior margin; pleura flat and broad with three segments which are produced laterally in flattened spines directed obliquely outward and backward with a slight curve, the posterior pair of spines are much shorter than the others, and the anterior pleural segments are grooved proximally.

The dimensions of a nearly perfect cranidium are: width 55 mm., length along median line 24.5 mm., length of genal spines about 11 mm. The dimensions of a nearly perfect pygidium are: extreme width 26 mm., width between the bases of the anterior pleural spines 17 mm., length along median line 7 mm.

*Remarks.* The geographic distribution of this species is widespread in the Niagaran formations of the Mississippi valley region, although it never seems to be a common species. It is a close ally of the European species *C. insignis*, and in earlier years was frequently so identified.

*Localities.* Hawthorn, Chicago Drainage Canal near Lemont, etc.

**Ceraurus hydei**, n. sp., pl. xxiv. fig. 22.

*Description.* A small species. Cephalon semi-circular in outline with rather slender genal spines whose extremities are opposite the posterior margins of the third thoracic segment. Glabella moderately convex, broadest in front, bounded by well defined dorsal furrows, its anterior margin not reaching the frontal margin of the head, its posterior margin occupying two-sevenths of the entire width of the head; frontal lobe sub-

elliptical in outline, occupying nearly one-half of the entire glabella; first and second lateral furrows directed at right angles to the axis and reaching less than one-fourth of the distance across the glabella; first and second lateral lobes of equal width at the margin of the glabella; third lateral furrows stronger and deeper than the others, directed obliquely backward, continuing across the glabella and becoming confluent with the occipital furrow in the middle so that the third lateral lobes are isolated as sub-triangular nodes. Occipital furrow about equaling in strength the third lateral glabellar furrows, directed forward from the lateral margins of the glabella and becoming confluent with the third lateral furrows in its median portion. Occipital segment flat, broadest in the middle. Cheeks moderately convex with a flattened marginal border which is produced into the genal spines and which is continued around the anterior extremity of the glabella. The lateral marginal furrows make a sharp turn near the genal angles and extend to the dorsal furrow parallel with the posterior margin of the head, leaving a narrow posterior marginal border. Palpebral lobes of moderate size, scarcely elevated above the general surface of the cheeks, situated opposite the anterior lateral furrows of the glabella. Free cheeks small, triangular. The posterior limbs of the facial sutures extend directly outward to the margins of the head, the anterior limbs describe a convex curve nearly parallel with the margin of the frontal lobe of the glabella to the anterior margin of the head.

Thorax with eleven segments; the axis moderately convex, occupying about one-third of the entire width, its sides nearly parallel, bounded by well-defined axial furrows. The pleura slightly convex. On each side of the axis a slight furrow nearly parallel with the axial furrow and lying about one-third the distance between it and the lateral margin, extends the entire length of the thorax. Between the axial furrows and these lateral furrows, each segment of the thorax is grooved, the grooves starting at the axial furrow from near the anterior margins of the segments and directed obliquely backward nearly to their posterior margins.

Pygidium very short with two conspicuous backwardly pointing spines; the axis sub-triangular with four segments, reaching nearly to the posterior margin; pleura indistinctly divided into three segments, the anterior ones being much the largest and slightly grooved near the axial furrows, they are produced posteriorly into the strong spines which are directed

obliquely outward and backward, the second segments are much smaller and are not grooved, their distal extremities make slight projections upon the posterior margin of the pygidium, third segments minute.

The dimensions of a nearly complete individual are: total length 24 mm., length of head 7.5 mm., length of thorax 14 mm., length of pygidium 2.5 mm., width of head at posterior margin 15 mm., width of pygidium at anterior margin 7.5 mm.

*Remarks.* This species is founded upon two nearly complete individuals both of which were collected by Mr. L. H. Hyde in whose honor the species is named. Some of the characters mentioned in the description are best shown in one of the specimens and some in the other one. The head of the species is much like that of a small individual of *C. niagarensis*, but it lacks the pitted surface of the cheeks and has the marginal border continuing around the front of the glabella, the most conspicuous difference between the two species is found in the pygidium, *C. niagarensis* having all the pleural segments produced into spines, while *C. hydei* has only the anterior pair of segments so produced. In the form of its pygidium the species resembles *C. pleurexanthemus* of the Trenton limestone faunas, but the cephalon is not tuberculate as in that species. The specimen here figured is preserved in the collections of the Walker Museum, the second specimen being still retained in the collection of Mr. Hyde. The greater portion of the outlines restored in the illustration have been drawn in from Mr. Hyde's specimen.

*Locality.* Chicago Drainage Canal, near Lemont.

#### Genus 17. **SPHAEREXOCHUS** Beyrich, 1845.

Complete body elongate sub-ovate in outline. Cephalon sub-globular, the cheeks much reduced; glabella nearly spherical with the two anterior pairs of lateral furrows nearly or quite obsolete, the posterior pair deeply impressed, curving backward to the occipital furrow and cutting off the sub-circular basal lobes from the glabella; eyes small. Thorax with ten segments, the axis prominent and bordered by strong axial furrows; the pleural segments smooth, convex. Pygidium smaller than the cephalon, the axis comparatively large, pleural segments three with free points.

**Sphaerexochus romingeri** Hall, pl. xxiv, figs. 16-19.

*Description.* Cephalon spheroidal, dorsal furrows strong and deep, sloping downward from the posterior margin to points

opposite the posterior lateral glabellar furrows where they bend much more abruptly downward to the frontal margin and continue across the front as a marginal furrow. The glabella smooth, sub-globular, comprising nearly the entire head, strongly protuberant anteriorly beyond the frontal margin; the two anterior pairs of lateral furrows and lobes often entirely obsolete, although the furrows are sometimes represented by slight undulations at the sides of the glabella; posterior furrows strong and deep, describing nearly a half circle and extending from the dorsal furrows in front to the occipital furrows behind, isolating the posterior lateral lobes which appear as two nearly circular nodes at the base of the glabella; occipital furrow deep and rather broad in its median portion, becoming narrower back of the posterior glabellar lobes, the occipital segment narrower, its surface elevated nearly as high as the surface, of the glabella in front of the occipital furrow. Cheeks reduced in size, sub-triangular in form; anterior limbs of facial sutures extending upward from the anterior margin parallel with and close to the outer margin of the dorsal furrows to the eyes, the posterior limbs directed at nearly right angles to the anterior limbs and cutting what appears to be the posterior margin of the head; eyes small, situated opposite the outer extremities of the posterior lateral glabellar furrows; fixed cheeks in front of the eyes occupied entirely by the dorsal furrows, back of the eyes they are broader, sub-triangular in outline with a deep post-marginal cheek furrow extending from the lateral terminations of the occipital furrow; free cheeks sub-quadrangular in form, flattened in their outer half, elevated within to the margin of the eyes, they are produced posteriorly to such an extent that the posterior limbs. of the facial sutures seem to cut the posterior margin of the head as in the order *Opisthoparia*.

Thorax with ten segments, strongly trilobed, the axis occupying more than one-third the total width, the inner half of the pleural lobes flattened, the outer half bent abruptly downward to the lateral margins.

Pygidium small, sub-semicircular in outline; the axis broad and strongly convex with three segments and a terminal flattened region; the pleural lobes much reduced in size, divided into three segments all of which are produced distally as free points.

The dimensions of a small but nearly perfect cephalon are: maximum width 14 mm., maximum length 10 mm., height from frontal margin to occipital segment 11 mm.

*Remarks.* This species, next to *Calymene niagarensis*, probably has the widest distribution of any of the trilobites of the Niagaran fauna of the Chicago area. The glabella is the portion of the species most commonly preserved, and the specimens are usually larger than the dimensions given above, a width of 18 mm. being a not unusual size. Specimens with the cheeks well preserved, and especially with the free cheeks are rarely met with. No specimen with the thorax and pygidium preserved has been observed from the Chicago area, but a specimen in that condition from Madison, Indiana, is preserved in the collections of the Walker Museum. Isolated pygidia are sometimes met with, but not often.

The species is somewhat closely allied to the European *S. mirus* Beyrich, but the body of the European species is broader throughout, the head of the American species is much more globular in form with the glabella much more protuberant beyond the frontal margin. The pygidium also of the American species has the pleural lobes much more reduced in size and with the free points of the pleural segments more produced.

*Localities.* Bridgeport, Lemont, Romeo, Joliet, etc.

#### Genus 18. **DEIPHON** Barrande.

Cheeks of the head reduced to elongate, recurved, spine-like processes; glabella sub-globular, comprised largely of the frontal lobe which is greatly produced anteriorly, the lateral furrows nearly or quite obsolete; free cheeks minute, eyes small, occupying the angle between the spine-like fixed cheeks and the glabella. Thorax with nine segments with free spiniform pleura. Pygidium short, with two pairs of lateral, curved, spiniform processes.

**Deiphon americanus**, n. sp., pl. xxiv, fig. 14.

*Description.* Glabella produced anteriorly, the nearly globular frontal lobe being larger than all the remaining portion of the cephalon and being extended in its entirety beyond the frontal margin. Back of the frontal lobe is a broad, rounded, occipital furrow marked at either extremity in the casts, by a conspicuous, circular, pit-like depression, these pits probably representing a nearly obsolete pair of lateral furrows; occipital segment narrow, arched transversely. Cheeks reduced to mere spine-like processes which extend obliquely outward and backward with a slight convex curve, their bases opposite the pit-like depressions at the extremities of the occipital furrow.

Eyes small, placed just in front of the bases of the cheek spines, in the rounded angle between the bases of the spines and the base of the globular frontal lobe of the glabella, they are raised on slight prominences which extend obliquely forward. Neither the pygidium nor the thorax have been observed from the Niagaran fauna of the Chicago area.

The dimensions of a nearly complete cephalon are: length along median line 8 mm., width of frontal lobe of the glabella 7.5 mm., width between extremities of cheek spines 19 mm.

*Remarks.* The presence of the genus *Deiphon* in the Niagaran fauna from near Batesville, Arkansas, has been noted by van Ingen<sup>1</sup>, the Arkansas specimens being identified by that author with the European *D. forbesi* Barr. A species of the genus has also been described and illustrated as *Sphærexochus pisum* by Foerste<sup>2</sup>, from beds of Clinton age in Ohio, the cheek spines not being preserved in the specimen figured, and the presence of the same species in the Niagaran beds of New York is mentioned. These occurrences, with the presence of the same genus in the Chicago area, show that this highly specialized genus had a wide geographic distribution in the North American epicontinental seas of Silurian age. In Europe the species *D. forbesi* Barr., is reported from England and Bohemia.

The species which is here described as *D. americana* differs from the European *D. forbesi* in its broader occipital furrow with the pit-like depressions at either end, and in the more posterior position of the cheek spines, the bases of these spines being nearly opposite the middle of the globular frontal lobe of the glabella in Bohemian examples as illustrated by Barrande<sup>3</sup>. The Arkansas specimens are probably identical with the Chicago species, while the Ohio specimens described by Foerste more closely resemble the European *D. forbesi*.

*Localities.* Joliet, Romeo, Chicago Drainage Canal near Lemont.

### Genus 19. **STAUROCEPHALUS** Barrande, 1846.

Complete body sub-ovate in outline. Cephalon with a conspicuous globular anterior glabellar lobe produced entirely beyond the frontal margin of the head, the lateral glabellar lobes reduced in size; cheeks of moderate size, convex, with short genal spines; eyes small. Thorax strongly trilobed,

<sup>1</sup>School of Mines Quart., Vol. 23, p. 35.

<sup>2</sup>Geol. Surv. Ohio, Vol. 7, p. 528, pl. 37A, figs. 14a—b.

<sup>3</sup>Syst. Sil. Bohême, Vol. 1, Supp., pl. 2, fig. 19.

with ten segments. Pygidium small, with three pairs of pleural segments which are produced distally in backwardly pointing free points.

**Staurocephalus obsoleta**, n. sp., pl. xxiv, fig. 15.

*Description:* Cephalon, exclusive of the anterior extension of the glabella, sub-semicircular in outline, the postero-lateral angles produced into rather short but slender genal spines. Glabella narrow in its posterior portion, sharply arched transversely, bounded by deep and strong dorsal furrows, tapering gently from the occipital furrow to a point nearly above the frontal margin of the cephalon, from this point the frontal lobe of the glabella expands abruptly into a large globular extension beyond the frontal margin of the cephalon, the diameter of the globular frontal lobe being equal to one-half the total length of the cephalon; lateral glabellar furrows and lobes obsolete; occipital furrow shallow, rounded in the bottom; occipital segment narrow, strongly arched transversely. Cheeks subtriangular in outline with an ill-defined, rather broad, marginal border, the eyes elevated nearly to the level of the glabella, facial sutures not distinguishable; in front of the eyes the surface of the cheek drops away nearly perpendicularly to the frontal margin, laterally the slope is very abrupt but not quite perpendicular, posteriorly and towards the dorsal furrows the slope is gentle; the outer margin of the cheeks is bordered by a row of fine, fringe-like spines, there being about twelve on each side between the genal angle and the base of the globular frontal lobe of the glabella. Thorax and pygidium not recognized.

The dimensions of the type specimen are: total length of head along median line 6 mm., length of globular frontal lobe of the glabella 4 mm., maximum width of head 9 mm.

*Remarks.* This species is one of the rarest trilobites in the Chicago fauna, a single specimen only having been observed. The species is a close ally of the European *S. purchisoni* Barr., but it may be distinguished from that species by the obsolete lateral glabellar furrows.

*Locality.* Chicago Drainage Canal, near Lemont.

Family 10. **PHACOPIDAE** Salter.

"Glabella tumid, widest in front. Free cheeks continuous, united anteriorly. Suture extending from in front of the genal angles inward to the eyes, and thence forward around the



glabella. Eyes generally large, always with distinct facets, schizochroal. Thorax of eleven segments, with grooved pleura. Pygidium usually large and of many segments; limb ribbed; margin entire or dentate." Beecher, Zittel-Eastman Text Book of Paleontology, p. 636.

Genus 20. **PHACOPS** Emmrich, 1839.

Entire body sub-ovate or sub-elliptical in outline. Cephalon sub-semicircular, the genal angles usually rounded; glabella strongly convex, very broad and expanded in front, the two anterior pairs of lateral furrows inconspicuous or obsolete; free cheeks more or less completely anchylosed with the fixed cheeks so that the facial sutures are frequently obscure; eyes large and prominent, with distinct, large facets. Thorax with strong axial furrows, segments eleven or twelve in number. Pygidium semi-circular with entire margin.

**Phacops handwerki**, n. sp., pl. xxiv, figs. 6-7.

*Description.* Entire body sub-elliptical in outline, tapering posteriorly. Cephalon semi-circular with rounded genal angles; glabella gently convex, sub-quadrangular, the anterior margin arcuate, reaching to the anterior marginal border of the cephalon, narrowest at its posterior extremity where it occupies about one-third of the entire width of the cephalon; lateral furrows of the glabella obsolete except the posterior ones which are narrow and deeply impressed and extend across the entire width of the glabella; the posterior lobe of the glabella very narrow with a small rounded node at each end, depressed between the large frontal lobe and the occipital segment. Occipital furrow narrow but rather deeply impressed. Occipital segment strongly arched transversely, the surface sloping with a convex curve into the occipital furrow. Cheeks sub-triangular, the facial sutures indistinguishable, the palpebral lobes large, their outer margins elevated to the height of the glabella; eyes very large, their length equaling one-half the length of the cephalon, the height of the faceted portion two-thirds their length; the outer portion of the cheeks sloping away from the eyes rather abruptly with a slightly convex curve.

Thorax strongly trilobite with eleven grooved segments; the axis arched transversely, occupying one-third the width of the body, tapering slightly to the posterior extremity; the inner half of the pleural lobes flattened with the surface nearly horizontal, the outer portion bent abruptly downward.

Pygidium sub-semicircular, twice as wide as long; the axis sharply defined, occupying one-third the width of the pygidium at its anterior extremity, tapering posteriorly to the narrowly rounded extremity which does not reach the posterior margin, marked anteriorly by two faint annulations; the pleura slightly flattened adjacent to the axis, sloping laterally with a gently convex curve to the margins, anteriorly they bear two faint annulations, but posteriorly they are smooth.

*Remarks.* The genus *Phacops* is not a common member of the Silurian faunas of America, Hall's *P. trisulcatus* from the Clinton beds of New York and Foerste's *P. pulchellus* from the Clinton of Ohio and Tennessee being the only species which have previously been described. Kindle\* has illustrated several specimens of heads from the Niagaran limestone of northern Indiana which he compares with *P. pulchellus*, but they much more closely resemble the species here described as *P. handwerki*, though two of his figures show the genal angles to be sharper than in the Chicago specimens, the pygidium illustrated by the same author is much more strongly segmented than *P. handwerki*. Foerste's original illustrations of *P. pulchellus* show a form with the base of the glabella much more contracted than the Chicago species, and with the pygidium much more strongly segmented on both axis and pleura.

The nearly perfect specimen illustrated on plate xxiv was collected by Mr. J. H. Handwerk of Joliet, after whom the species is named.

*Locality.* Chicago Drainage Canal, near Lemont.

#### Genus 21. **DALMANITES** Emmrich, 1845 .

Entire body sub-oval in outline, generally angular posteriorly. Cephalon sub-crescentiform, the genal angles usually produced into spines; glabella prominent, broadest in front, with three pairs of well-marked lateral furrows; cheeks large with clearly defined facial sutures; eyes large and prominent, coarsely faceted. Thorax with eleven segments, axial furrows well-defined, axis strongly convex and narrower than the pleural lobes. Pygidium large, usually sub-triangular, the posterior extremity frequently pointed or mucronate ; axis prominent with numerous segments.

#### **Dalmanites platycaudatus**, n. sp., pl. xxv, figs. 3-5.

*Description.* Entire body sub-ovate in outline, with a long caudal spine. Cephalon depressed-convex, semi-elliptical in

\*28th Ann. Rep. Dep. Geol. and Nat. Res., Indiana, p. 484, pl. 24, figs. 9-12.

outline to the ends of the genal spines, with a flat, rounded, median lip-like extension in front, the genal spines about two-thirds the length of the head along its median line. Glabella depressed-convex, occupying less than one-third the entire surface of the head, limited laterally by well-defined nearly straight dorsal furrows, key-stone shaped in outline, widest in front, the width at the occipital furrow being about three-fifths that across the frontal lobe; frontal lobe transversely sub-elliptical in outline, a little elevated above the surface of the lateral lobes, its length five-eighths its width, occupying nearly one-half the entire glabella; first lateral lobes wedge-shaped in outline, twice as wide at the dorsal furrow as at their inner extremities; second lateral lobes quadrangular, smaller than the first; third lateral lobes similar to the second but slightly smaller; externally all three lateral lobes on each side are confluent along the dorsal furrows, but in the internal casts the lateral furrows continue to the dorsal furrows; the inner extremities of the first lateral furrows are nearly opposite the anterior extremities of the eyes, from their origin they are directed obliquely outward and forward, they are most deeply impressed toward their inner extremities; second lateral furrows nearly transverse in direction, not continuous across the median portion of the glabella and not confluent with the dorsal furrows; third pair of lateral furrows similar in all respects to the second except that they may be a little longer. Occipital furrow continuous across the posterior margin of the glabella, joining the dorsal furrows on either side, it is most strongly impressed at the lateral extremities, becoming fainter across the median portion of the glabella. Occipital segment with nearly parallel anterior and posterior margins, its length a little greater than that of either the second or third lateral glabellar lobes, and its width a little greater than the glabella at its posterior margin. Cheeks sub-triangular in outline with a broad flattened marginal border which is continuous around the anterior margin of the glabella with a flat rounded median extension in front. Anterior limbs of the facial sutures parallel with the margin of the glabella from the anterior extremities of the eyes towards the anterior margin of the head, then continuing parallel with its frontal margin completely around the anterior extremity of the glabella, the sutures from the two sides being continuous; the posterior limbs directed laterally from the posterior extremities of the eyes, describing a slightly sigmoidal curve

and cutting the lateral margins a little back of a line through the centers of the eyes. Inner surface of the palpebral lobes sloping gently upward from the dorsal furrows, the outer margins bent abruptly upward to the facial sutures at the inner borders of the eyes. Eyes large, sub-crescentiform, their length a little more than half the length of the glabella along its median line, the height of the faceted portion a little less than one-half their length; the faceted portion nearly vertical posteriorly but gradually sloping inward more and more to the anterior extremity where the slope is nearly forty-five degrees. Laterally from the eyes the surface of the cheeks is gently convex to the marginal furrows, the marginal border is rather broad and flattened anteriorly, becoming obsolete back of a line passing through the posterior extremities of the eyes in the extension of the cheeks into the genal spines. The posterior cheek furrows are continuous from the dorsal furrows nearly to the lateral margins, laterally they curve backward but are not confluent with the lateral cheek furrows.

Thorax with eleven segments; the axis strongly defined, moderately convex, occupying less than one-third the entire width; pleural lobes flattened on top for more than one-half their width and then curving rather abruptly downward to the lateral margins; the pleura conspicuously grooved longitudinally, the grooves nearly bisecting each segment from the dorsal furrow to the point where they bend downward, then curving backward and becoming obsolete before reaching the extremities of the segments.

Pygidium sub-triangular in outline, with a long, slender, flattened caudal spine whose length is more than one-half the total length of the pygidium. Axis well defined, depressed-convex, occupying less than one-third the width of the pygidium anteriorly, tapering posteriorly and terminating within the proximal extremity of the caudal spine, divided into twelve segments by transverse furrows which are deeply impressed laterally in the internal casts but are much fainter across the median portion of the axis. The pleural lobes are flattened for more than half their width from the furrows, and then slope rather abruptly to the lateral margins, they are divided into eight grooved segments which curve backward distally and become obsolete just within the lateral margin, posteriorly the segments become much fainter, the last one or two sometimes being scarcely distinguishable.

The dimensions of a small, nearly complete individual are: total length 41.5 mm., greatest width between extremities of genal spines 21.5 mm., length of head along median line 11 mm., length of thorax 14 mm., length of pygidium 16.5 mm.. The dimensions of a nearly perfect head are: total length to extremities of genal spines 43.5 mm., greatest width 44 mm., length along median line 26 mm. The dimensions of a nearly perfect pygidium are: length 42 mm., length of axis 17.5 mm., length of caudal spine 24.5 mm., total width 30.5 mm.

*Remarks.* This species is one of the commonest members of the genus *Dalmanites* in the Chicago fauna. It is allied to the British *D. longicaudatus* Murch., but differs from that species in its flat caudal spine and in the less produced and less mucronate anterior extension of the cephalon. The species also resembles *D. limulurus* (Green) from the New York Niagaran faunas but has the caudal spine flattened and much more elongate.

The smaller, nearly complete specimen and the nearly perfect pygidium illustrated on plate xxv, were collected by Mr. L. H. Hyde.

*Locality.* Chicago Drainage Canal near Lemont.

***Dalmanites illinoiensis***, n. sp., pl. xxv, figs. 1-2.

*Description.* Pygidium large, sub-triangular in outline, wider than long, with a short caudal spine which is broad and flat at its base becoming rapidly narrower and terminating in a very acute point. The axis together with the segmented portion of the pleural lobes, form a semi-elliptical, depressed convex area surrounded laterally and posteriorly by a broad, smooth, flattened marginal border which is produced posteriorly into the caudal spine. The axis is depressed-convex, sharply defined by dorsal furrows, its width at the anterior margin of the pygidium is about two-ninths of the greatest width of the pygidium, it tapers posteriorly and terminates in a bluntly rounded extremity at the edge of the flattened marginal border, it is divided into fifteen segments by transverse furrows which are deeply and sharply impressed laterally but across the median portion they are shallower and less strongly defined. The surface of the pleural lobes is flattened for about one-half their width from the dorsal furrows and then gently convex to the inner edge of the marginal border, they are divided into eleven deeply grooved segments, the grooves ex-

tending from the dorsal furrows to the inner edge of the marginal border. Head and thorax not known.

The dimensions of a very perfect pygidium are: total length to end of caudal spine 57 mm., length of axis 36 mm. total width 67 mm., width of axis at anterior margin of pygidium 15 mm.

*Remarks.* This pygidium has been observed from several different localities and always attains about the same size, but no heads have been seen which can be associated with it. In general form the pygidium resembles that of *D. verrucosus* Hall, more closely than any other species, but it does not have the tubercles of that species and the marginal border is broader and more conspicuous.

*Localities.* Joliet, Bonfield, Chicago Drainage Canal near Lemont.

**Dalmanites vigilans** Hall, pl. xxiv, figs. 1-4.

*Description.* Cephalon moderately convex, semi-elliptical in outline to the ends of the genal spines, with an anterior, median, upwardly curving, spine-like extension, the entire length of which has in no case been observed. Surface of the glabella flattened back of the first pair of lateral furrows and convexly curved to the front, wedge-shaped in outline, widest in front, limited laterally by the dorsal furrows which are well defined except opposite the posterior half of the first lateral glabellar lobes, the entire glabella occupying about one-third of the cephalon; frontal lobe transversely sub-elliptical in outline, most strongly elevated at its posterior border, sloping to its anterior border with a gently convex curve, occupying about one-half of the entire glabella, its length about five-sevenths its width; first lateral lobes wedge-shaped in outline, twice as wide at their outer margin as within, their posterior halves confluent with the cheeks across the dorsal furrows; second lateral lobes quadrangular, smaller than the first and somewhat confluent with them externally; third lateral lobes similar to the second but slightly smaller and wholly separate from them, first lateral furrows directed obliquely outward and forward, not continuous across the median portion of the glabella, their inner extremities in front of the anterior margins of the eyes, most deeply impressed internally, becoming nearly obsolete at the dorsal furrows; second lateral furrows nearly transverse in their direction, not continuous across the median portion of the glabella, deeply impressed within, becoming

obsolete externally or connected with the dorsal furrows with faint depressions; third lateral furrows similar to the second except that they are continuous to the dorsal furrows with their full depth. Occipital furrow continuous across the posterior margin of the glabella, most deeply impressed toward its lateral extremities. Occipital segment with nearly parallel anterior and posterior margins, its width a little greater than the glabella at its posterior margin. Cheeks sub-triangular in outline with a marginal border of moderate width which is continuous around the anterior extremity of the glabella, and from which the anterior median spine-like extension is produced. Anterior limbs of the facial sutures passing forward from the anterior extremities of the eyes close along the outer margins of the dorsal furrows, then crossing the dorsal furrows opposite the lateral extremities of the frontal lobe of the glabella and continuing around the anterior margin of the glabella close to the anterior edge of the frontal lobe; posterior limbs of the facial sutures not well shown in the specimens. Surface of the palpebral lobes sloping abruptly upward from the dorsal furrows with the outer border bent still more abruptly upward, so bringing the inner margin of the eye far above the level of the glabella. Eyes large, their outer margins describing a little more than a semi-circle, the faceted surface nearly vertical, separated exteriorly from the cheeks by an undercut furrow, the entire surface elevated above the surface of the glabella. The surface of the cheeks is most prominent anteriorly from the eyes, they slope away from the base of the eyes, laterally and anteriorly, rather abruptly to the lateral cheek furrows which are well defined, then after this interruption they continue their abrupt slope to the margin, becoming less abrupt anteriorly; posteriorly each cheek is marked by a marginal furrow which is continuous behind the eyes with the occipital furrow, and joins the lateral cheek furrows at their outer extremities; the genal angles are produced posteriorly into spines of moderate length.

Pygidium sub-triangular in outline, rather strongly convex, mucronate posteriorly but not produced into an elongate caudal spine; the axis well defined, about one-third the width of the Pygidium anteriorly, divided into eleven segments by transverse furrows which, in the casts, are deeply impressed laterally becoming much shallower across the median portion of the axis; pleural lobes flattened within, sloping rather abruptly at the sides to the lateral margins without a flattened marginal border, divided into about nine grooved segments which do

not quite reach the lateral margins and which become obsolescent posteriorly. Thorax unknown.

The dimensions of an imperfect cephalon with the anterior median projection only partially preserved are: total length along the median line 24.5 mm., length of glabella from posterior margin of head 15 mm., length of anterior spine so far as preserved, measured from the anterior margin of the glabella, 9.5 mm., total width 33 mm., height of eyes above surface of glabella 4.5 mm. The dimensions of a nearly complete pygidium are: length 17 mm., width 20 mm., length of axis 13 mm., width of axis anteriorly 7 mm.

*Remarks.* This species was originally described by Hall from specimens collected in the dolomitic Niagaran limestone at Waukesha, Wisconsin. The type specimens, judging from the illustrations, agree in all respects with the Chicago specimens, but the anterior spine-like prolongation of the head is drawn as a short, acuminate process. More than the broken base of this process is rarely seen, and in no individual has its full extent been observed. In Hall's type specimen the process was probably incomplete and doubtless appeared to be as his figure shows, but in reality the figure is probably erroneous in this particular.

At a later date a trilobite occurring commonly in the Waldron fauna of Indiana was identified with this Wisconsin species; the pygidia of the two forms are much alike, but the cephalon of the Waldron form does not possess the elongate anterior process, and the eyes are not nearly so highly elevated above the surface of the glabella. The two forms are clearly distinct, and the name *D. halli* has been applied to the Waldron species in the bibliographic list of species in the earlier portion of this Bulletin (p. 195).

*Localities.* Joliet, Chicago Drainage Canal near Lemont.

***Dalmanites arkansanus*** van Ingen, pl. xxiv, fig. 5.

*Description.* Cephalon sub-triangular in outline, bluntly rounded in front, moderately convex, flattened on the axial portion between the eyes, the surface sloping abruptly to the lateral margins. Glabella sub-pentagonal in outline, the anterior margin coincident with the anterior margin of the head, broadest through the middle of the frontal lobe, width along the posterior margin one-half the maximum width, bounded laterally by shallow dorsal furrows which are somewhat deepened as they approach the occipital furrow; frontal lobe large, sub-



rhomboidal or sub-triangular in outline; first and second lateral lobes confluent at their outer margins, the first lobes sub-triangular in outline, the second sub-circular or sub-elliptical, but little more than half the size of the first ; third lateral lobes much smaller than the second, wider at their outer extremities than within; first lateral furrows the longest, broad and of moderate depth, straight, extending obliquely inwards and backwards from just in front of the anterior margins of the eyes, not joined across the median portion of the glabella, the width of the unfurrowed median region being one-half the width of the glabella along its posterior margin; second lateral furrows nearly transverse in direction, situated opposite the posterior third of the eyes, not joined across the glabella, their inner extremities lying directly behind the inner extremities of the anterior furrows, they are deeply impressed within and, in the casts, are joined with the dorsal furrows externally by very slight depressions; third lateral furrows deeply impressed, their inner extremities curving slightly forward and terminating directly behind the inner extremities of the two anterior pairs of furrows. Occipital furrow narrow, most deeply impressed laterally, arched forward in its median portion. Occipital segment broadest in the middle. Cheeks rather large, sub-triangular in outline, genal angles produced into short spines, the lateral and posterior margins with a raised marginal border which is rounded laterally but becomes sharply elevated posteriorly as it approaches the axial portion of the cephalon; the marginal furrows within the raised marginal borders are deepest and most sharply defined posteriorly behind the eyes, they are shallower and broader as they round the genal angles and then become a little deeper in the middle portion of the lateral margins; within the marginal furrows the surface of the cheeks is moderately convex. The palpebral lobes elevated at their outer margins to the height of the surface of the glabella; the eyes are large and prominent, their length being about five-twelfths the length of the cephalon along its median line, and the height of the faceted portion three-fifths their length. Thorax and pygidium not recognized.

The dimensions of a nearly complete head are: length along median line 24 mm., width at extremities of genal spines 31.5 mm., maximum width of glabella 16 mm., width of glabella posteriorly 9.5 mm.

*Remarks.* This species is readily distinguished from any other members of the genus in the Chicago fauna by reason of

the anterior position of the front margin of the glabella, the cheeks in this species not being connected around the front of the glabella by a flattened border. It is an unusual type of *Dalmanites* in the American Silurian faunas, the only other known occurrence being in the St. Clair limestone of Independence County, Arkansas, the species in the two regions apparently being identical.

*Locality.* Chicago Drainage Canal, near Romeo and near Lemont.

***Dalmanites verrucosus*** Hall. pl. xxv, figs. 6-7.

*Description.* Head with genal spines attached, sub-crescentiform in outline, the outer margin describing a semi-ellipse, the surface depressed-convex. Glabella depressed-convex, key-stone shaped, broadest in front, limited by well-defined dorsal furrows; frontal lobe transversely sub-elliptical in outline, occupying about one-half the entire glabella, its length nearly two-thirds its width; first lateral lobes wedge-shaped in outline, nearly twice as wide at the dorsal furrows as at the inner extremities of the lateral furrows; second lateral lobes quadrangular, smaller than the first; third lateral lobes similar to the second but a little smaller; lateral furrows deeply impressed, not continuous across the median third of the glabella, the anterior pair extend obliquely inward and backward from their points of origin on the dorsal furrows and are a little less sharply defined than the two posterior pairs which are transverse in their direction, the posterior pair are connected across the median portion of the glabella by a slight depression. Occipital furrow deeply impressed laterally, shallower in the middle and arched a little forward. Occipital segment about equal in width to the posterior glabellar lobes, its surface level with the glabella. Cheeks convex, sub-triangular in outline; the marginal border rather broad and flattened, continuous around the anterior extremity of the glabella, abruptly separated from the convex portion of the cheeks by the marginal furrows, and produced posteriorly into rather broad genal spines; the posterior cheek furrows are strong and deep, originating at the dorsal furrows and continuing to the marginal furrows with which they coalesce in front of the bases of the genal spines; eyes prominent, their summits a little higher than the surface of the glabella, their faceted surface describing a sub-semicircle.

Pygidium sub-triangular or sub-elliptical in outline, abruptly produced posteriorly into a sharp spine of moderate

length; the axis about two-sevenths of the entire width at the anterior margin, limited laterally by strong lateral furrows, tapering posteriorly to the base of the caudal spine, with eleven or twelve annulations, the transverse furrows being deeply impressed laterally, becoming broader and shallower and arched forward over the median half of the axis; the pleura moderately convex with a slight flattening upon the lateral margins which can scarcely be designated as a marginal border, marked by eight or nine strongly defined segments, all but the posterior two or three of which are deeply grooved.

The surface of the head, except in the furrows on the marginal and posterior borders and palpebral lobes, is covered with rather coarse, scattered, rounded tubercles. The pygidium is also tuberculate, each annulation of the axis bearing a strong median tubercle with two or three upon each lateral slope; upon the pleural segments each division bears a line of low tubercles along its summit which are much less conspicuous than those of the axis.

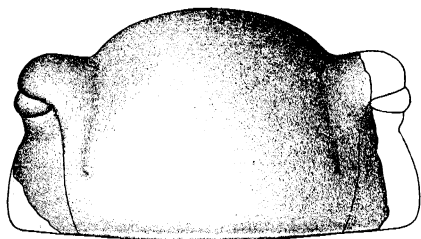
The dimensions of an imperfect head are: width 37 mm., approximate length along median line 22 mm., approximate length to tips of genal spines 36 mm. The dimensions of an imperfect pygidium are: approximate length 40 mm., width 46 mm.

*Remarks.* This species has not been actually observed in the Chicago area, but it occurs rarely in the dolomitic limestone at Bonfield and elsewhere in Illinois, and may yet be found in our area. Its tuberculate surface markings will always serve to distinguish it from other similar species of the genus.

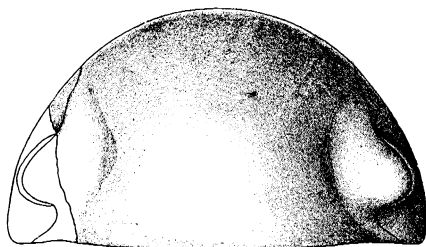
*Localities.* Bonfield Ill., and Jersey County, Ill.

## EXPLANATION OF PLATE XVI.

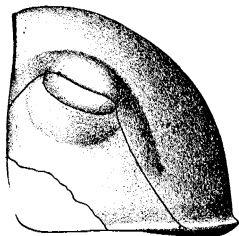
- Figures 1-3 *ILLAENUS HARRISI* n. sp. .... p. 218  
 Anterior, dorsal and lateral views of the type specimen,  
 from Bridgeport. (Pal. Coll. Walker Museum, No. 8,613  
 Collected by G. F. Harris) .
- Figures 4-6 *ILLAENUS GRAFTONENSIS* M. & W..... p. 223  
 Dorsal, anterior and lateral views of a nearly perfect  
 cephalon from Joliet. (Pal. Coll. Walker Museum, No. 6,  
 855, Gurley Collection. )
- Figures 7-9 *ILLAENUS TRANSVERSALIS* n. sp.....p. 224  
 Anterior, dorsal and lateral views of the type specimen,  
 the lateral and anterior views restored in part, from  
 Bridgeport. (Pal. Coll. Walker Museum, No. 8,614.  
 Collected by G. F. Harris.)
- Figures 10-12 *ILLAENUS CHICAGOENSIS* n. sp.....p. 220  
 Anterior, dorsal and lateral views of the type specimen,  
 from Hawthorn. (Pal. Coll. Walker Museum, No. 9,910,  
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- Figures 13-16 *ILLAENUS IMPERATOR* Hall..... p. 225  
 13-15, Dorsal, anterior and lateral views of an  
 incomplete small cranidium. 16, Dorsal view of a  
 pygidium. Both specimens from Joliet. (Pal. Coll.  
 Walker Museum, No. 10,728, Van Horne Collection.)



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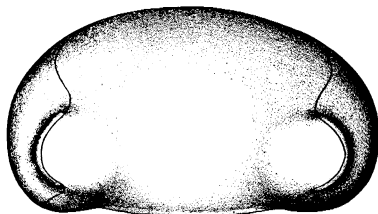
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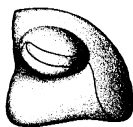
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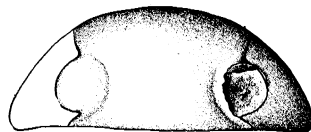
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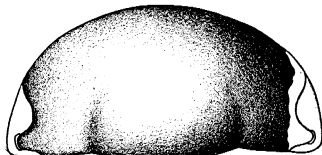
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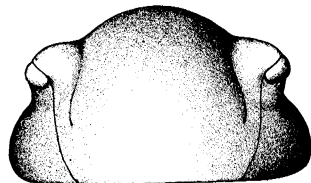
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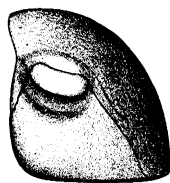
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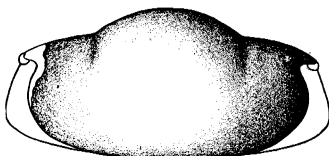
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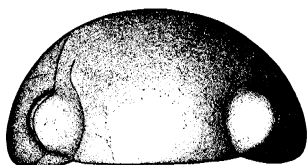
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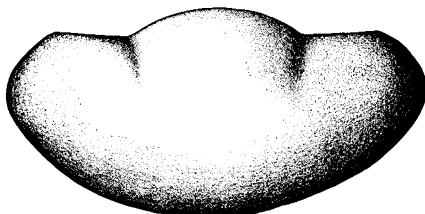
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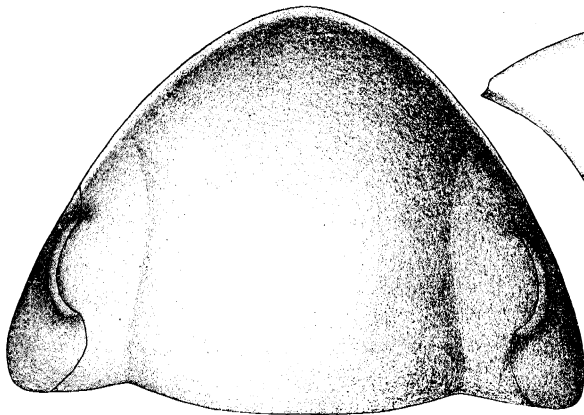
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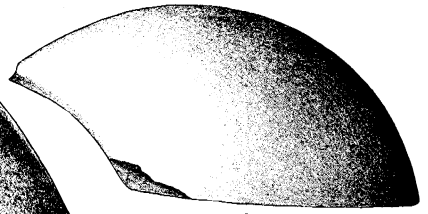
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## EXPLANATION OF PLATE XVII.

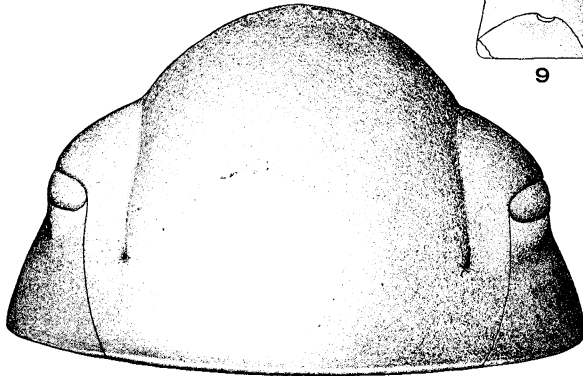
- Figures 1-5 *ILLAENUS INSIGNIS* Hall..... p. 215  
 1-3, Dorsal, anterior and lateral views of a nearly complete cephalon. 4-5, Lateral and dorsal views of a nearly complete pygidium. Both specimens from Hawthorn. (Pal. Coll. Walker Museum, No. 9,902, Van Horne Collection.)
- Figures 6-9 *ILLAENOIDES TRILOBA* n. sp.....p 226  
 (See also Plate XIX., Figs. 12-14.)  
 6, Dorsal view of an incomplete specimen preserving the head, thorax and pygidium from near Lemont. (Pal. Coll., Walker Museum, No. 9,871, collected by L. H. Hyde). 7-9, Anterior, dorsal and lateral views of a nearly complete cephalon, from Bridgeport. (Pal. Coll. Walker Museum, No. 10,732. Van Horne Collection.)



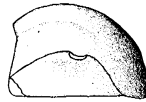
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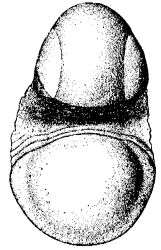
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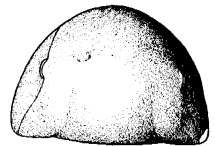
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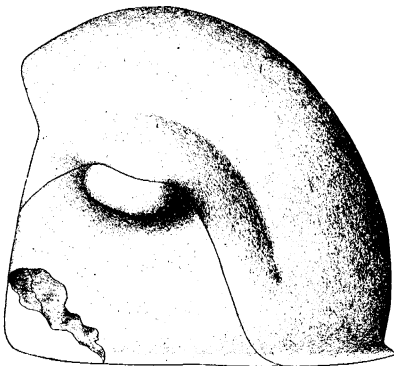
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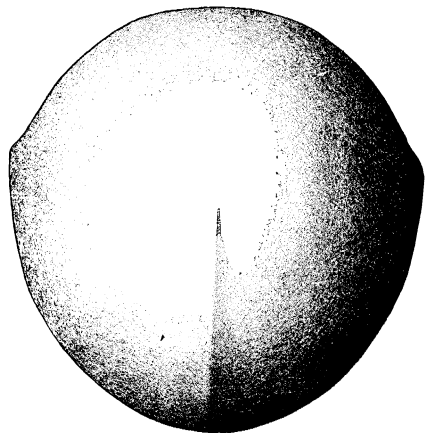
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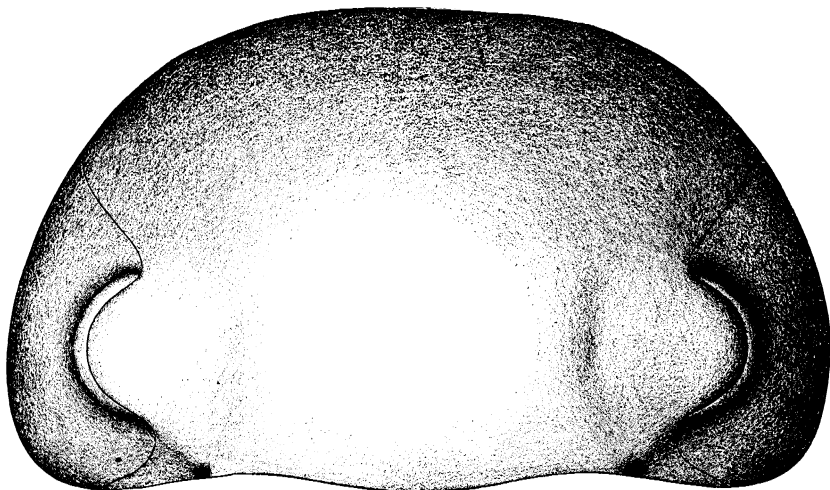


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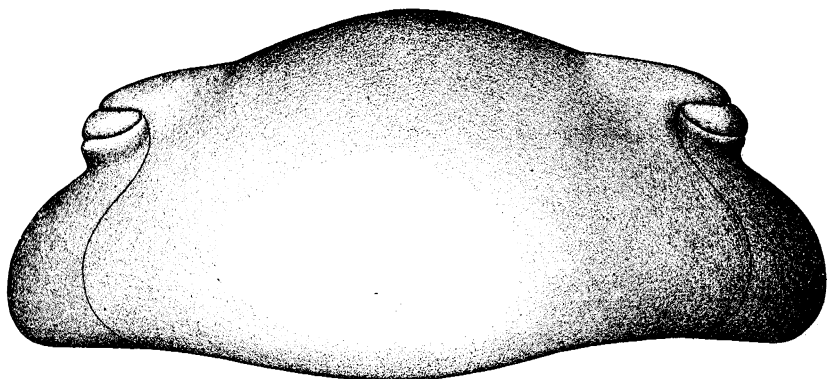
## EXPLANATION OF PLATE XVIII.

- Figures 1-3 *ILLAENUS IOXUS* Hall ..... p 222  
Dorsal, anterior and lateral views of a complete  
cephalon, from Joliet. (Pal. Coll. Walker Museum, No.  
10, 729, Van Horne Collection).
- Figures 4-6 *ILLAENUS ARMATUS* Hall..... p. 222  
Lateral, anterior and dorsal views of a complete  
cephalon, from Lockport. (Pal. Coll. Walker Museum,  
No. 9,896, Van Horne Collection).

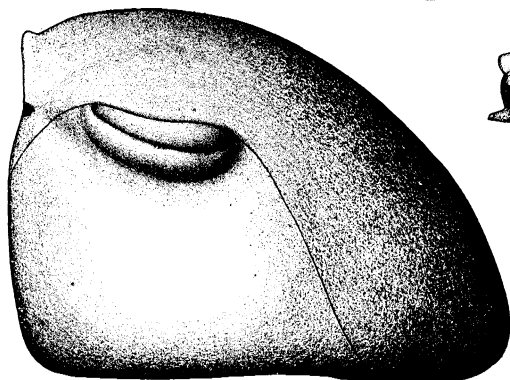




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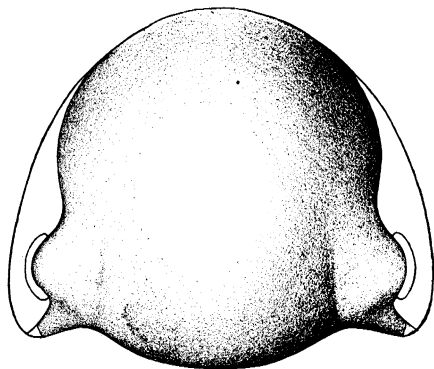
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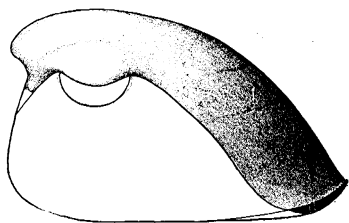
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## EXPLANATION OF PLATE XIX.

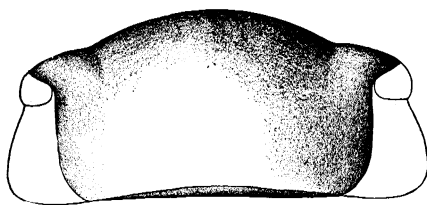
- Figures 1---6 *ILLAENUS CUNICULUS* Hall..... p 219  
 1-3, Dorsal, anterior and lateral views of a nearly complete  
 cranidium, from Wauwatosa, Wis. (Pal. Coll. Walker Museum  
 No. 10,730.) 4-6, Dorsal, lateral and anterior views of a small  
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- Figures 7-11 *ILLAENUS NIAGARENSIS* Whitfield..... p 219  
 7-8, Dorsal and lateral views Of an incomplete specimen pre-  
 serving the head, thorax and pygidium. 9, Anterior view of  
 the same specimen, from Joliet. (Egan Collection, Chicago  
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 nearly complete pygidium, from Lockport. (Pal. Coll. Walker  
 Museum, No. 10,731, Van Horne Collection.)
- Figures 12-14 *ILLAENOIDES TRILOBA* n. sp..... p. 226  
 (See also Plate X V I I, Figs. 6-9.)  
 12-13, Lateral and dorsal views of a large cranidium. (Pal.  
 Coll. Walker Museum. No. 9,897). 14, Dorsal view of a large  
 pygidium. Both specimens from near Lemont. (Pal. Coll.  
 Walker Museum, No. 9,872. Collected by L. H. Hyde.)



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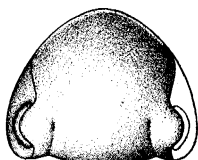
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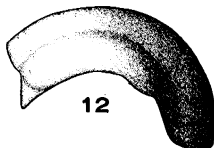
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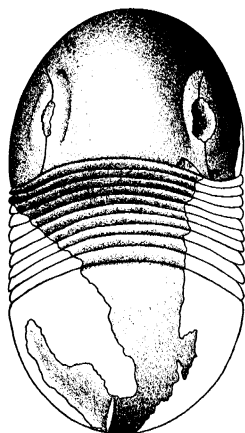
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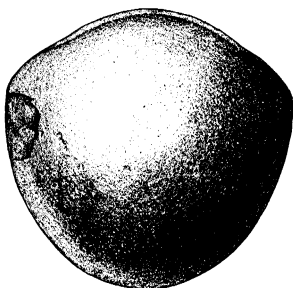
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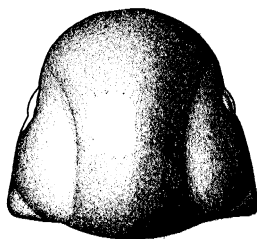
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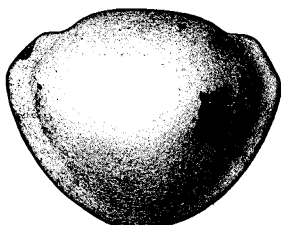
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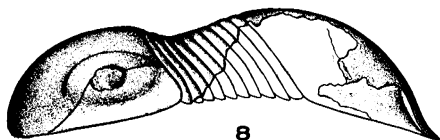
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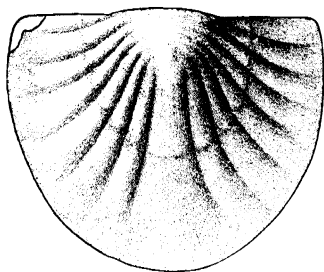
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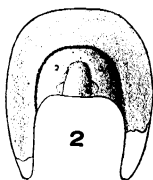
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## EXPLANATION OF PLATE XX.

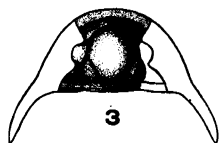
- Figure 1 *BRONTEUS ACAMAS* Hall ..... p. 232  
 Dorsal view of a nearly complete pygidium, from Romeo. (Pal. Coll. Walker Museum, No. 10,733. Collected by J. H. Ferris.)
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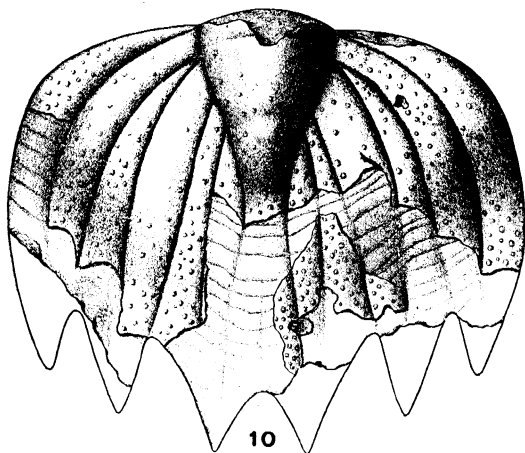
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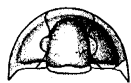
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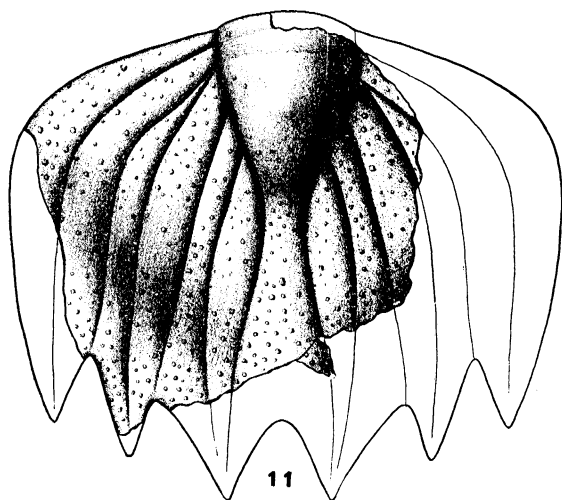
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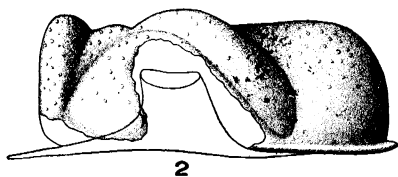
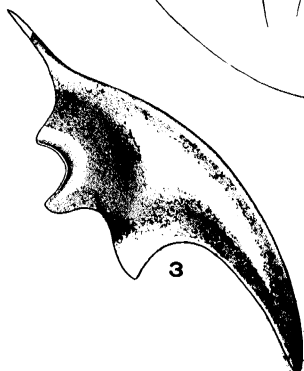
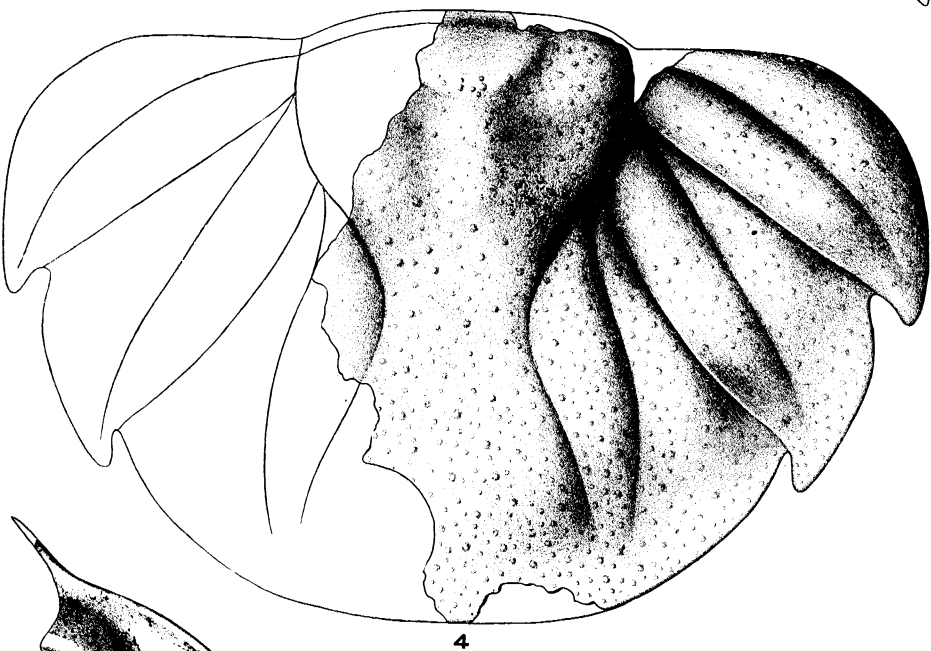
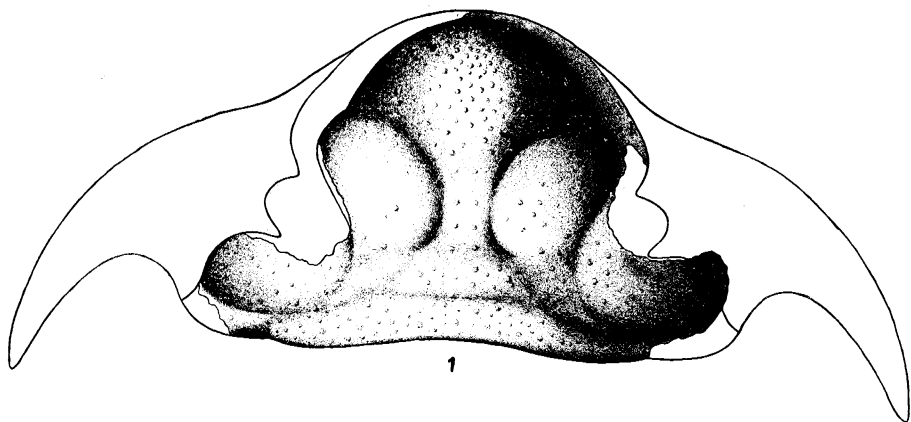


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- Figures 1-4 METOPOLICHAS PUGNAX W. & M.....p. 242  
1-2, Dorsal and lateral views of an incomplete cranidium with the cheeks restored in outline. 3, Dorsal view of a free cheek. Both specimens from Bridgeport. (Egan Collection, Chicago Academy of Sciences.) 4, Dorsal view of an incomplete pygidium, restored in outline. (Pal. Coll. Walker Museum, No. 9,861, Van Horne Collection.)

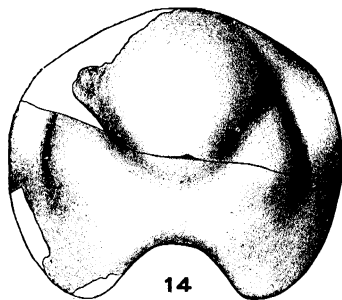
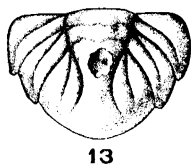
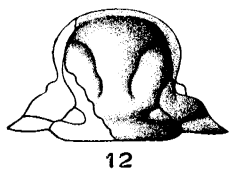
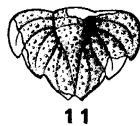
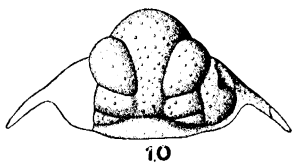
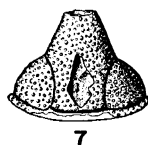
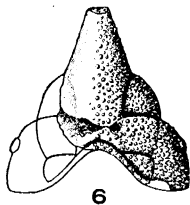
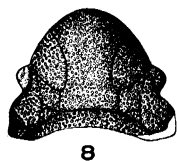
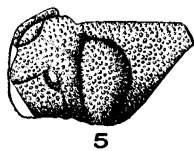
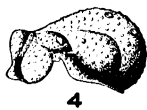
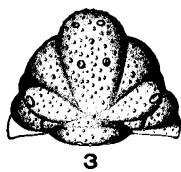
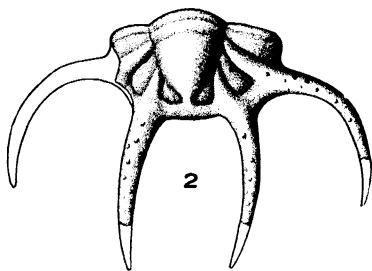
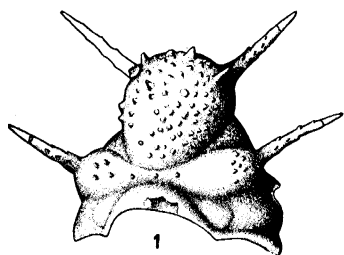
PLATE XXI



## EXPLANATION OF PLATE XXII.

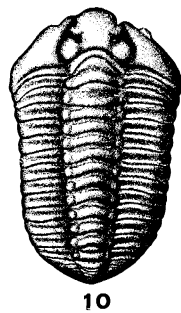
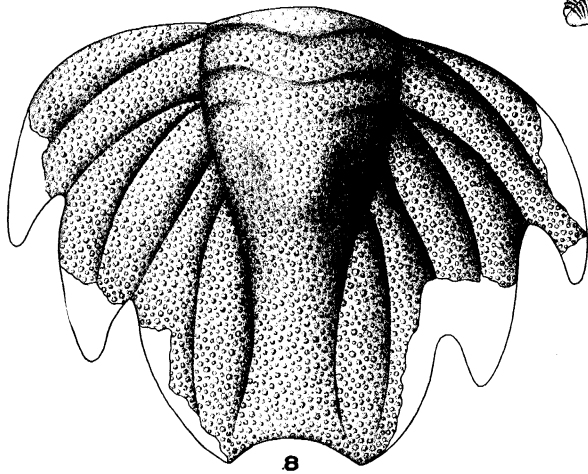
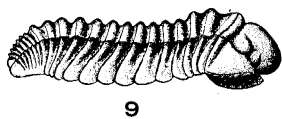
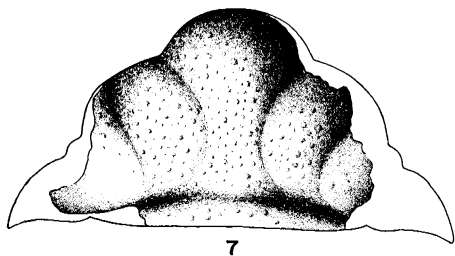
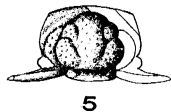
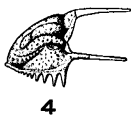
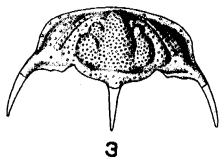
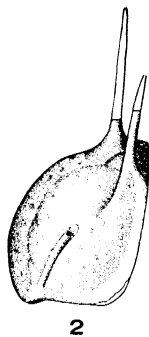
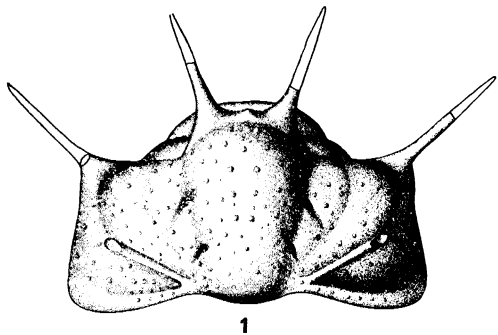
- Figures 1-4 *CORYDOCEPHALUS PHLYCTAINODES* Greene..... p. 234  
 1, Dorsal view of a slightly distorted cranidium preserving some of the spines, from near Lemont. (Pal. Coll. Walker Museum, No. 10,741, Collected by J. H. Handwerk.) 2, Dorsal view of a nearly complete pygidium, from near Lemont. (Pal. Coll. Walker Museum, No. 10,743.) 3-4, Dorsal and lateral views of a nearly complete cranidium, from near Lemont. (Pal. Coll. Walker Museum, No. 10,742.)
- Figures 5-7 *DICRANOPELTIS NASUTA* n. sp..... p 240  
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- Figures 8-9 *DICRANOPELTIS TELLERI* n. sp..... p. 241  
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 (See also Plate XXIII., Figs. 7-8.)  
 A nearly complete hypostome believed to belong to this species, from Hawthorn. (Pal. Coll. Walker Museum, No. 10,744, Van Horne Collection.)





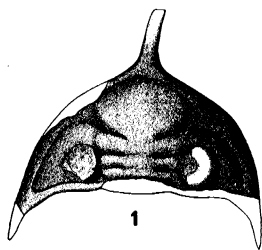
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- Figures 1-2 *CERATOCEPHALA GONIATA* Warder.....p. 255  
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- Figures 5-6 *ODONTOPLEURA ILLINOIENSIS* n. sp.....p. 253  
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- Figures 9-10 *CALYMENE NIAGARENSIS* Hall.....p. 261  
 Lateral and dorsal views of a nearly complete individual, from near Lemont. (Pal. Coll. Walker Museum, No. 10,746.)

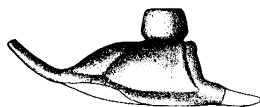


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- Figures 6-7 *PHACOPS HANDWERKI* n. sp.....p. 271.  
 6, Dorsal view of a nearly complete cephalon. 7, Dorsal view of a nearly complete individual. Both specimens from near Lemont. (Pal. Coll. Walker Museum, No. 10,749. Collected by J. H. Handwerk.)
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- Figure 22 *CERAURUS HYDEI* n. sp.....p. 264  
 Dorsal view of a nearly complete individual, from near Lemont. (Pal. Coll. Walker Museum, No. 9,873. Collected by L. H. Hyde.)



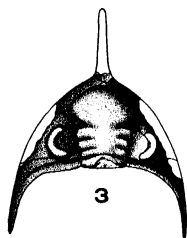
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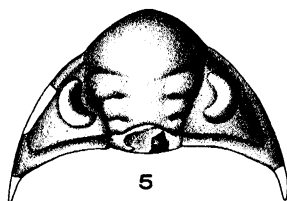
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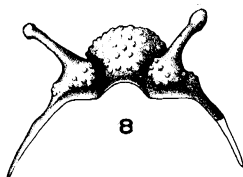
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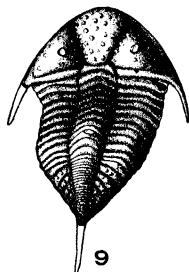
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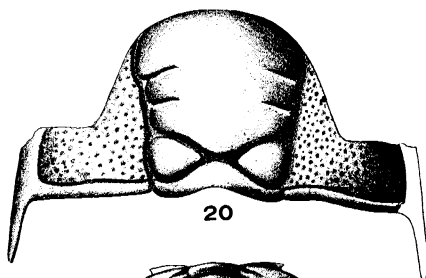
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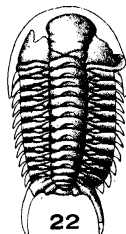
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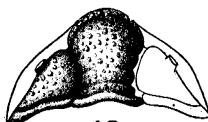
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## EXPLANATION OF PLATE XXV.

- Figures 1-2 *DALMANITES ILLINOIENSIS* n. sp..... p. 275  
 1, Dorsal view Of a nearly complete pygidium, from Bonfield, Ill.  
 (Pal. Coll. Walker Museum, No. 6,835, Gurley Collection.) 2,  
 Dorsal view of another less complete pygidium, from near  
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- Figures 3-5 *DALMANITES PLATYCAUDATUS* n. sp..... p 272  
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 ker Museum, No. 10,752.) 4, Dorsal view of a nearly  
 complete pygidium, from near Lemont. (Pal. Coll.  
 Walker Museum, No. 9,878. Collected by L. H. Hyde.) 5,  
 Dorsal view of a nearly complete individual, from near  
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 by L. H. Hyde.)
- Figures 6-7 *DALMANITES VERRUCOSUS* Hall..... p. 280  
 6, Dorsal view of an incomplete cephalon, from Bonfield,  
 Ill. (Pal. Coll. Walker Museum, No. 6,834, Gurley Collec-  
 tion.) 7, Dorsal view of an incomplete pygidium, from  
 Jersey County, Ill. (Pal. Coll. Walker Museum, No. 6,833,  
 Gurley Collection.)

